Total Maximum Daily Load for Chloride in the Upper Santa Clara River

STAFF REPORT

California Regional Water Quality Control Board,
Los Angeles Region

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TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

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1. INTRODUCTION

Chloride levels in two reaches of the Santa Clara River that are located near the Los Angeles-Ventura County line (i.e., "Upper Santa Clara River") exceed the water quality objective (WQO) for chloride established in the Water Quality Control Plan, Los Angeles Region *(Basin Plan),* (RWQCB-LA, 1994)). Due to excessive chloride, the Upper Santa Clara River's beneficial use for agricultural supply that is designated in the *Basin Plan* is not supported, and the Upper Santa Clara River is listed on the United States Environmental Protection Agency's (USEPA) 303(d) list of impaired waterbodies in California. The Clean Water Act requires that a Total Maximum Daily Load (TMDL) be established to restore the Upper Santa Clara River and implement the established water quality standard for chloride.

This document provides the background information used by California Regional Water Quality Control Board, Los Angeles Region (Regional Board) to develop a TMDL for chloride in the Upper Santa Clara River. The goal of this TMDL is to determine the measures needed to meet the WQO for chloride in the Upper Santa Clara River, protect agricultural supply and groundwater recharge beneficial uses, and remove the Upper Santa Clara River from the 303(d) list of impaired waterbodies in California.

1.1. Regulatory Background

The elements of this TMDL and the schedule of its promulgation are specified by statute and consent decree. Section 303(d) of the federal Clean Water Act (CWA) requires that "each State shall identify those waters within its boundaries for which the effluent limitations are not stringent enough to implement any water quality standard applicable to such waters." The CWA also requires states to establish a priority ranking for waters on the 303(d) list of impaired waters and establish TMDLs for such waters.

The elements of a TMDL are described in 40 CFR 130.2 and 130.7 and Section 303(d) of the CWA, as well as in USEPA guidance (U.S. EPA, 2000). A TMDL is defined as the "sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background" (40 CFR 130.2) such that the capacity of the waterbody to assimilate pollutant loading is not exceeded. A TMDL is also required to account for seasonal variations and to include a margin of safety (MOS) to address uncertainty in the analysis (U.S. EPA, 2000).

States must develop water quality management plans to implement the TMDL (40 CFR 130.6). The USEPA has oversight authority for the 303(d) program and is required to review and either approve or disapprove the TMDLs submitted by states. If USEPA disapproves a TMDL submitted by a state, USEPA is required to establish a TMDL for that waterbody.

The Regional Board identified over 700 waterbody-pollutant combinations in the Los Angeles Region where TMDLs would be required (RWQCB-LA, 1996, 1998). A schedule for the development of TMDLs in the Los Angeles Region was established in a consent decree (Heal the Bay Inc., et al. v. Browner C 98-4825 SBA) approved on March 22, 1999.

For the purpose of scheduling TMDL development, the consent decree combined over 700 waterbody pollutant combinations into 92 TMDL analytical units. Analytical unit 31 consists of segments of the Santa Clara River and tributaries with impairments related to chloride. This report summarizes the analyses performed by the Regional Board staff to develop a TMDL for chloride for the Upper Santa Clara River.

This TMDL is based on a preliminary draft TMDL released on July 19, 2002. On August 1, 2002, Regional Board staff held a public meeting to consult with the public and interested stakeholders about the preliminary draft TMDL and the environmental effects of the proposed TMDL. At the meeting, the proposed TMDL Implementation Plan requirements, significant environmental issues, reasonable alternatives and mitigation measures were discussed. This meeting fulfilled the requirements of early public consultation under California Environmental Quality Act (CEQA) guidance (Section 15083).

This TMDL addresses methods of reducing chloride loading in the Upper Santa Clara River to meet the WQO in the impaired reaches. It defines a numeric target in Reaches 5 and 6, identifies sources and develops methods for linking chloride sources to water quality, allocates chloride loads (expressed as concentration), and sets forth an Implementation Plan to meet the WQO.

1.2. Problem Statement

Chloride levels in the Upper Santa Clara River exceed water quality standards associated with agricultural supply (AGR). Additionally, chloride levels in the Upper Santa Clara River exceed the groundwater objective for chloride in certain basins underlying the Upper Santa Clara River and thereby exceed water quality standards associated with groundwater recharge (GWR). Crops grown with water diverted from the Santa Clara River include avocado, which is sensitive to chloride. Research suggests that chloride concentration above 100-120 mg/L cause leaf-tip burn in avocado and reduce crop yield. This research was summarized in a Regional Board staff report to support Regional Board Resolution 00-20, Amendment to the Water Quality Control Plan for the Los Angeles Region to Modify the Chloride Objectives for the Reach at Santa Paula of the Santa Clara River. Appendix 1 provides background and references regarding water quality for agricultural supply uses, including uses for irrigation of salt sensitive crops. Table 1 summarizes the chloride impairments of the Santa Clara River reaches.

TABLE 1. SUMMARY OF SANTA CLARA RIVER AND CHLORIDE IMPAIRMENTS BY REACH

Reach*	Reach Name	Geographic Description	Chloride Concentration on 1998 303(d) List	Miles Impaired
1	Estuary	Tidally influenced mouth of Santa Clara River upstream to the 101 Bridge	Not listed	None
2	Highway 101	Upstream (east) of Highway 101 Bridge to the Freeman Diversion	Not Listed	None
3	Santa Paula	Upstream of Freeman Diversion to Street A Bridge in Fillmore	100 mg/L (objective of 80 mg/l changed to 100 mg/L by Resolution 00-20)	13.24
4	Fillmore	Upstream of Street A Bridge in Fillmore to the Blue Cut Gauging Station	Not Listed	None
5	Blue Cut (EPA Reach 6)	Upstream of USGS Blue Cut Gauging Station to the West Pier Highway 99	105 mg/L**	9.21
6	Highway 99 (EPA Reach 7)	Upstream of Highway 99 to Bouquet Canyon Bridge	105 mg/L***	3.42
7	Bouquet Canyon	Upstream of Bouquet Canyon to Lang Gauging Station	Not Listed	None
8	Above Lang Gauging Station	Lang Gauging Station to headwaters	Not Listed	None

*Different reach numbers reported by EPA (1999), RWQCB-LA (1998) and RWQCB-LA (1996) are replaced here by those in the RWQCB-LA *Basin Plan* for consistency with ongoing planning activities.
** 9 measurements ranging from 54 to 138 mg/L with standard deviation of 22 mg/L
*** 89 measurements ranging from 10 to 138 mg/L with a standard deviation of 21 mg/L

Table 2 summaries Regional Board efforts to achieve a long-term chloride policy in the Santa Clara River.

TABLE 2: HISTORY OF REGIONAL BOARD ACTIONS TO MODIFY CHLORIDE LEVELS

BOARD ACTIONS TO MODIFY CHLORIDE LEVELS IN SANTA CLARA RIVER, SUMMARY OF COMMENTS RECEIVED, AND MODIFICATIONS COMPLETED IN RESPONSE.			
Date	Action	Comment Received	Response
August 1, 2002	Public Meeting on Draft Chloride TMDL, including scoping of environmental issues regarding the proposed TMDL implementation plan	(1)Point of use attainment of objective not sufficient, (2) MOS not necessary (3)Sensitivity to endangered species, groundwater interactions and reclaimed water plans unknown	(1)Revised numeric target to WQO of 100 and set MOS equal to the modeled assimilative capacity (2)Recommended additional stakeholder studies to be considered on endangered species during TMDl reopener (3) Hydroldogical study recommended in implementation plan specifically expanded to address issues of groundwater and reclaimed water.
Feb. 18, 2002	Draft Chloride TMDL to stakeholders: 100 mg/L at first Agricultural diversion, reduction for POTW loads	(1)Implementation Plan does not provide sufficient time (2) Surface water levels now exceed crop needs.	(1)Implementation Plan modified as per stakeholder assessment of requirements (2)Triggers for more rapid implementation if aquatic life threatened (3)Alternative water supply required for affected Agricultural diversions.
Dec. 7, 2000	Objective Change to Board: 143 mg/L Upper River	(1)Remedy too costly for benefit (2)Evidence of surface water increases exceeding objective	(1)Adopt interim limit of 143 mg/L (2)Staff prepares TMDL (3)Staff evaluates alternative less-costly remedies
Jul.27, 2000	Objective Change to Board: 143 mg/L Upper River	(1)Insufficient Public Participation	(1)Postpone action (2)Staff holds additional public meetings on 8/2/00; 8/28/00; 10/16/00; 11/16/00
Apr.13, 2000	Objective Change to Board: 143 mg/L Upper River, 100 mg/L Lower River	(1)Remedy too costly	(1)Adopt 100 mg/L in Lower River (2)Staff prepares cost analysis
Feb. 28, 2000	Objective Change to stakeholders: 143 mg/L Upper River, 100 mg/L Lower River	(1)Not sufficient protection of Agricultural uses in upper watershed	(1)Staff gathers reports from land owner that no historic salt sensitive crops in upper watershed
Apr. 7, 1999	Chloride TMDL to stakeholders: Load reduction, maintain current POTW loads,	(1)Insufficient evidence of surface water chloride concentration increases	(1)Staff prepares proposed chloride objective change

BOARD ACTIONS TO MODIFY CHLORIDE LEVELS IN SANTA CLARA RIVER, SUMMARY OF COMMENTS RECEIVED, AND MODIFICATIONS COMPLETED IN RESPONSE.			
Date	Action	Comment Received	Response
	reduce Ag loads with BMPs		
Jan. 27, 1997	Resolution 97-02: Objective of 190 mg/L except where Ag use	(1)Not protect crops in Ventura County	(1)Adopt new objective where no Agricultural beneficial use. (2)Staff prepares chloride TMDL where Ag use exists
Mar.26, 1990	Resolution 90-04: Interim limit of 190 mg/L	(1)Replace 190 mg/L interim limit with a permanent objective.	(1)Adopt interim limit (2)Staff prepares Basin Plan Amendment to revise chloride objectives.
Mar 27, 1978	Resolution 78-02Modify Objectives		(1)Adopt Objectives
Apr 26, 1976	Resolution 75-10 Set Objectives	(1)Data insufficient	(1)Adopt Objectives (2)Staff collects additional data

Data show chloride concentrations in Reaches 5 and 6 of the Upper Santa Clara River exceed the WQO of 100 mg/L, and these reaches are listed on the 1998 303(d) list of impaired waterbodies in California. Figures 1, 2, and 3 depict the Santa Clara River watershed, the TMDL reach locations, the reaches impaired by chloride, respectively. Although the 2002 303(d) list is not finalized, recent data support the 1998 listing for chloride in these reaches. A review of the chloride concentrations at the Blue Cut Gauging Station (Blue Cut) suggests that the chloride concentrations are increasing (Figure 5).

In 1999, the rolling annual average (the average of any consecutive 12 months of data) chloride concentration at Blue Cut was 109 mg/l, an increase from an average of 76 mg/L in the 1970s, an average of 94 mg/L in the 1980s, and an average of 101 mg/L in the 1990s. The annual average at Blue Cut increased to 113 mg/L in 2000, to 127 mg/L in 2001 and to 130 mg/L during the early months of 2002. The most recent value available is 138 mg/L measured on May 29, 2002.

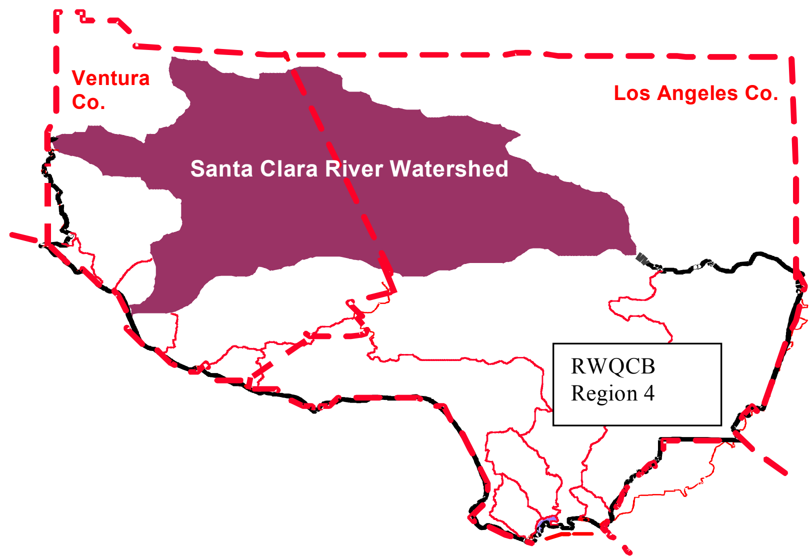
1.3. Environmental Setting

This section describes the environmental setting of the Upper Santa Clara River and the Santa Clara River watershed.

1.3.1. TMDL Reaches

The downstream end of the two Santa Clara River reaches addressed in the TMDL is the United States Geological Survey Gauging Station at Blue Cut (Blue Cut), which lies approximately 1.5 miles downstream from the Los Angeles-Ventura County Line in Ventura County (Figure 3). The remainder of the watershed addressed by this TMDL lies within Los Angeles County. The next reach upstream, which is also impaired, extends upstream from the west pier of the Highway 99 bridge (Highway 99), near Interstate Highway 5 and the City of Santa Clarita, to Bouquet Canyon Road Bridge.

1.3.2. Overview of Watershed



Size of watershed: approximately 1,200 square mile.

Length of river: approximately 100 miles

The Santa Clara River is the largest river system in southern California that remains in a relatively natural state and is a high quality resource for much of its length. The river originates in the northern slope of the San Gabriel Mountains in Los Angeles County, traverses Ventura County, and flows into the Pacific Ocean through the Santa Clara River Estuary between the cities of San Buenaventura and Oxnard.

Much of the watershed was originally Spanish land grants used for grazing cattle and dry-land farming. Urbanization since the late 1940's has continuously modified the land use, resulting in discharge of imported water and municipal wastewater. Since the 1950's, agriculture has changed from seasonal dry-land farming to predominantly year-round irrigated farming of citrus, avocado and row crops. More recently, land use in the Upper Santa Clara River has changed with the construction of residential neighborhoods and the municipal, recreational, commercial and industrial infrastructure to support them. Some rural neighborhoods remain with septic use, animal facilities and open space. The use of open land for grazing is still prevalent. Mining of minerals, sand and gravel, and oil extraction are also present. The Los Padres and Angeles National Forests protect and preserve open space and natural ecosystems while providing recreational opportunities. Table 3 shows the aggregate land use percentages for Reaches 5 and 6. Those land uses labeled with an asterisk were delineated from the Southern California Association of Governments (SCAG) land use; the remainders were from BASINS.

The climate in this region is Mediterranean, typical of the Southern California Coast. Average annual precipitation varies from 14 inches (in.) along the cost, to about 17 in. near Santa Paula in the intermediate altitudes, to more than 25 in. in the surrounding mountains. Temperatures range from 90+ ^{o}F at the coast in late summer and early fall to below freezing during the winter in the surrounding mountains. The mountains are composed of marine and terrestrial sedimentary and volcanic rocks. The basins are filled with deposits of sands, silts, and clays resulting from the exposure of the underlying formations.

TABLE 3. LAND USE PERCENTAGE FOR REACH 5 AND 6

Land Use	Santa Clara River, Reach 5	Santa Clara River, Reach 6
Deciduous	0.77	0.09
Mixed Forest	0	0.98
Orchard*	0.01	0.21
Coniferous	0.31	3.77
Shrub/Scrub	87.27	68.29
Grassland	0.47	2.64
Golf Course/Park*	0	0.78
Pasture*	0.78	0.41
Cropland*	2.08	0.34
Marsh	1.7	0.03
Barren	0.38	0.68
Water	0.09	0.3
Residential*	4.32	1.38
High Density Residential*	1.09	11.11
Comm./Industrial*	3.67	6.06

* Land use extent calculated using 1993 SCAG database; others are from BASINS

Extensive patches of high quality riparian habitat are present along the length of the river and its tributaries. Endangered fish, the unarmored stickleback and the steelhead trout, are resident in the river. One of the largest of the Santa Clara River's tributaries, Sespe Creek, is designated a wild trout stream by the state of California and supports significant spawning and rearing habitat. Sespe Creek is also designated as a wild and scenic river by the United States Forest Service in Los Padres National Forest. Piru and Santa Paula Creeks, which are tributaries to the Santa Clara River, also support good habitats for steelhead trout. In addition, the river serves as an important wildlife corridor. An estuary exists at the mouth of the river and supports a large variety of wildlife.

The Regional Board has granted National Pollutant Discharge Elimination System (NPDES) permits to five major dischargers (average effluent flow rate exceeds 0.5 million gallons per day (MGD)) and numerous minor dischargers in the Santa Clara River watershed. The major dischargers include two Water Reclamation Plants (WRP) that discharge into the Upper Santa Clara River, the Saugus and Valencia WRPs. In addition, there is a WRP that discharges to the Santa Clara River estuary and two WRPs that discharge to the middle reaches of the Santa Clara River, downstream of the Upper Santa Clara River. Minor discharges are typically related to dewatering and construction projects and are covered by general NPDES permits. The number of minor discharge permits varies in number and duration each year. The major and minor discharges are discussed in Section 2.3, Source Assessment.

Among the minor NPDES discharge permits are those for storm runoff from construction sites. In 2000, there were 310 sites enrolled under the construction storm water permit with a similar number of sites located in the upper and lower watershed. The majority of these are residential sites 10 acres or larger in size.

1.3.3. Surface and Groundwater Interaction

Surface flow both infiltrates into groundwater basins underlying the Santa Clara River and is augmented, at some times and locations, by groundwater flow. At Reach 5 (Figure 3), which is listed as impaired by chloride (EPA 1998 303(d) list – EPA's Reach 7) and lies between Blue Cut and Highway 99, shallow, impermeable beds underlie the downstream end of the reach at Blue Cut. The overlying alluvial aquifers are thin and close to the surface. Groundwater is commonly discharged at this location from the underlying Santa Clara River Valley Basin (Figure 4) and mixes with surface flow.

Upstream from Blue Cut, the Valencia Water Reclamation Plant (Valencia WRP) provides continuous discharge into Reach 5. In summer, conservation discharges from Castaic Lake also enter the river via Castaic Creek between Blue Cut and the Valencia WRP. Immediately upstream of the Valencia WRP lies the San Gabriel and Holser Fault system that act as a partial groundwater barrier causing groundwater discharge and comparatively constant surface flow (Slade, 1986). Old Highway 99, adjacent to Interstate 5, crosses the river at about this point.

Reach 6 lies upstream of Reach 5, between Highway 99 and Bouquet Canyon Bridge, and is also listed as impaired for chloride (EPA 1998 303(d) list –EPA's Reach 8). Groundwater is discharged from upstream basins and augmented by flows from the Saugus WRP, Bouquet Canyon and smaller flows from San Francisquito and Dry Canyons. Just upstream of the Bouquet Canyon Bridge the river is almost always dry.

Reach 7 lies between the Bouquet Canyon Road Bridge and the Lang Gauging Station. The reach is usually dry, with water moving downstream beneath the bed of the river through an alluvial aquifer basin that is deeper, wider and has higher transmissivity values than are found in the rest of the Santa Clara Valley Basin (Slade, 1986). Placerita Canyon, which is also known as the South Fork of the Santa Clara River, enters the river valley here and its surface flow disappears into the alluvial basin near the Bouquet Canyon Bridge. Additional flow percolates into the groundwater near Lang Gauging Station from Tick Canyon. Municipal wells also pump the aquifer extensively in this area.

Reach 8 lies upstream of the Lang Gauging Station, where surface water flows in Soledad Canyon. Within that canyon, shallow impermeable beds, thinning aquifers, and a narrowed streambed cause the flow to appear above the surface. Mint, Agua Dulce, and Aliso Canyons provide tributary flow to the Soledad canyon. The headwaters of the river are found around the town of Acton, where a thin groundwater basin absorbs overland flow upstream of where it rises to be discharged to the surface in the Santa Clara River at the upper end of Soledad Canyon.

2. THE TMDL PROCESS

This section discusses the elements of a TMDL prescribed by the Clean Water Act. It includes problem identification, development of numeric targets, source assessment, linkage analysis, allocations, critical conditions and seasonality, margin of safety and future growth.

2.1. Problem Identification

The Regional Board's 303(d) listings are based on impairments of water quality standards. Water quality standards consist of the following elements: 1) numeric and/or narrative objectives, 2) beneficial uses, and 3) an antidegradation policy. In California, beneficial uses are designated by the nine regional water quality control boards in their respective Water Quality Control Plans (*Basin Plans*). Water quality objectives are contained in both regional and Statewide Water Quality Control Plans. This section summarizes the applicable water quality standards. The standards for chloride were exceeded in the Santa Clara River by the measurements described in Table 1.

2.1.1. Water Quality Objectives

The WQO of the upper reaches of the Santa Clara River for chloride is 100 mg/L. The WQO of the upper reaches of the Santa Clara River was set at 80 mg/L above Highway 99 and 90 mg/L above Blue Cut by the Regional Board in 1975. These values were revised to 50 mg/L above Lang and 100 mg/L above Blue Cut in 1978. In 1993 the Department of Water Resources (DWR) confirmed that historical surface water quality data supported these objectives. Regional Board staff also reviewed water quality data in 1994 without recommending a WQO change. More recently during a public hearing in December 2000, the Regional Board assessed existing and historic data in the Upper Santa Clara River and maintained the WQO for chloride at 100 mg/L.

A WQO of 80 mg/L was established for the downstream reaches of the Santa Clara River in 1975 (Resolution 75-21) and revised to 100 mg/L in 1978 (Resolution 78-2). The Regional Board determined in December 2000 that a chloride objective of 100 mg/L was necessary to prevent impacts to salt sensitive crops (Resolution 00-20) for Reach 3. A summary of the Regional Board's actions regarding chloride objectives and interim limits for chloride is provided in Table 4.

The WQOs were based on historical in-river data covering an extensive time period, dating from 1930, and an extensive area, including 42 samples in the headwaters above Lang gauging station between 1951 and 1978 and 6 samples taken from Bouquet Canyon during the same period. Higher in-river concentrations measured during the 1960's are attributed to the discharge of oil exploration wastes, which were subsequently regulated, and were not used to determine the in-river concentrations to be protected from degradation. Specifically, instantaneous values as low as 37 mg/L were measured in 1952 at Blue Cut when the annual average value was 100 mg/L. Annual averages at Blue Cut rose during the 1960's, decreased with the regulation of oil exploration discharges, and then increased from 76 mg/L to 94 mg/L to 101 mg/L with increasing WRP effluent discharge in the decades between 1970 and 2000. The historical and natural chloride concentrations depicted by the WQOs are all 100 mg/L or below for the upper Santa Clara River.

TABLE 4. REGIONAL BOARD ACTIONS ON CHLORIDE OBJECTIVE IN THE SANTA CLARA RIVER.

Chloride Resolution	Board Action	Surface Water Quality Objective	Groundwater Quality Objective
75-21	Establish Surface and Groundwater Quality Objectives in *Basin Plan*.	Set at 80 mg/L above west Pier Highway 99, 90 mg/L at the Los Angeles Ventura County Line, and 80 mg/L downstream.	Set at 100 mg/L for Acton, 150 mg/L between Blue Cut and lower Bouquet Canyon, including Castaic Creek, 100 mg/L for Placerita, South Fork and Mint Canyon and 30 mg/L for upper Bouquet Canyon.
78-02	WQO updated based on additional water quality data.	Modified to 50 mg/L above Lang Gauging Station, 100 mg/L for all other reaches above Santa Paula.	Modified in Mint Canyon to 150 mg/L and in lower Bouquet and San Francisquito to 100 mg/L.

Chloride Resolution	Board Action	Surface Water Quality Objective	Groundwater Quality Objective
90-04	"Drought Policy": Regional Board response to widespread exceedances of effluent limit.	Set interim chloride discharge limits of 190 mg/L for the region.	
97-02	"Chloride Policy": Regional Board response to continuing elevated in-river chloride levels region-wide.	Modified surface WQO to 190 mg/L for Region except in Santa Clara and Calleguas where interim effluent limits of 190 mg/L were extended.	
00-20	Updated objective based on new data in the Lower Santa Clara and directed staff to complete a chloride TMDL for the upper Santa Clara River.	Modified WQO to100 mg/L for the Santa Clara River everywhere below Blue Cut Gauging Station and above Highway 101.	
00-21	Extends interim limits while TMDLs completed.	Temporarily extends an interim limit of 143 mg/L in Santa Clara and 190 mg/L in Calleguas. The interim limit expired in December 2001.	

The chloride WQO for the Santa Clara River was interpreted as an average in the 1978 *Basin Plan*. However, previous and subsequent *Basin Plans*, which were developed in accordance with the Porter Cologne Water Quality Control Act, do not use averaging methods to interpret the WQO. A Basin Plan Amendment is currently under preparation to reconcile differences in the interpretation of the WQO between the earlier Basin Plan versions, the current Basin Plan WQO, and the TMDL. The implementation plan of this TMDL allows for the development of a site-specific objective (SSO) in accordance with the anticipated Basin Plan Amendment, if necessary.

The groundwater WQO for aquifers underlying these reaches was set in 1975 at 100 mg/L, with the exception of 150 mg/L in the vicinity of Bouquet, Castaic and Mint Canyons. In 1993, the DWR recommended reducing the 150 mg/L objective for groundwater between the Santa Clara River at its confluence with Castaic Creek, just downstream from Highway 99, to its confluence with Bouquet Canyon, to 100 mg/L. These recommended changes have not yet been considered for incorporation into the *Basin Plan*.

2.1.2. Beneficial Uses

The beneficial uses of the reaches of the Santa Clara River addressed in this TMDL are those identified in the *Basin Plan* (1994). These uses are designated as existing (E), potential (P), or intermittent (I) uses. All beneficial uses must be protected. A full description of each of these beneficial uses is included in the *Basin Plan* and appears in Appendix 5. The Santa Clara River provides water for irrigation, for support of aquatic life, and for groundwater recharge. Groundwater is extracted along the Santa Clara River for agricultural and municipal supply uses, among others.

Guidance values documented in summaries of state and federal regulations and in Regional Board resolutions support the existing chloride objective to protect the most sensitive beneficial use, agricultural supply. A summary of these values is provided in Table 5.

Among the designated beneficial uses, those most sensitive to chloride under current conditions are agricultural use for direct irrigation of avocados at diversions at the downstream end of the reaches addressed in this TMDL, and groundwater recharge, which also supports agricultural uses. Staff have not identified other existing beneficial uses currently impaired by chloride, or expected to be negatively impacted by the remedies specified in this TMDL except for rare, threatened, or endangered species (RARE) habitat that requires continued surface flow. TMDL remedies that reduce flow will require careful analysis to assure that the remedy will protect beneficial uses associated with habitat.

TABLE 5. GUIDANCE VALUES AND REGIONAL BOARD RESOLUTIONS SPECIFYING CHLORIDE REQUIREMENTS FOR SANTA CLARA BENEFICIAL USES

Beneficial Use	Guidance Value mg/L	Source	Notes
Agriculture (Avocado)	100	Resolution 00-20	Based on agricultural research, growers and expert opinion for Santa Clara River Watershed
General Agriculture	106	Marshack, 2001	RWQCB-Central Valley summary of state and federal chloride requirements
Agriculture (depending on specific crop needs)	100-355	RWQCB-LA *Basin Plan*	None
Freshwater Aquatic life 4 day average continuous concentration	230	EPA, 1988*	None

Beneficial Use	Guidance Value mg/L	Source	Notes
Municipal Supply	250	California and EPA Secondary MCL	None
Freshwater Aquatic life 1 hour average maximum concentration	860	EPA, 1988	None
Endangered Species steelhead trout chronic toxicity	923	EPA, 1988	None

*Ambient Water Quality Criteria for Chloride – 1998, USEPA, NTIS No. BD88-175

Staff recently learned that strawberry crops will be planted in 2002 and irrigated with diverted river water at Camulos Ranch (Mathew Freeman Personal Communication, July 8, 2002). Strawberries are also sensitive to chloride concentrations approximately equal to those which affect avocado. Citrus crops, especially older Valencia orange, in the Piru Basin have already been widely replaced in the eastern Piru Basin by avocado, bell peppers, and other row crops like strawberries

2.1.2.1 Agricultural Supply Beneficial Use

The agricultural supply beneficial use (AGR) is defined by the *Basin Plan* as "uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing." For the Santa Clara River watershed, an existing or potential agricultural supply water beneficial use is listed for all reaches except the headwaters. Some agricultural beneficial use is present upstream from the Blue Cut Gauging Station, but local growers cultivating the land report that salt sensitive crops such as avocados or strawberries have not been grown since at least 1975 due to cold weather limitations (Resolution 00-20).

The Santa Clara River is diverted at the Blue Cut Gauging Station in Ventura County, just downstream from the reaches addressed by this TMDL, for avocado irrigation (Resolution 00-20). Agricultural experts predict that cultivation of this crop will continue, a fact documented by the California Department of Conservation which finds the Santa Clara River in Ventura County to be unique farmland appropriate for avocado (www.consrv.ca.gov/dlrp/fmmp).

The potential effects of increasing chloride concentrations on avocado and strawberry crops can be seen and are reported by farmers in the adjacent Calleguas Creek Watershed (Resolution 00-20 and Appendix 1). Some growers are no longer able to use their land for the most economically desirable crops which could have been grown under the conditions that existed in 1975 (Jones, 1990). Reported adjustments include switching to more chloride-tolerant crops even if they are less profitable, finding alternative sources of water and income (i.e. abandoning agricultural production), and selling their land (Zone Mutual Water District, 1990). While some farmland has been converted to other uses in Ventura County, the voters affirmed "SOAR" (Save Open and Agricultural Resources) initiatives during the 1980s and 1990s, which limit re-zoning of agricultural land for other land uses.

2.1.2.2 Groundwater Recharge Beneficial Use

Groundwater basins underlying the Santa Clara River are used for agricultural and municipal water supply. The groundwater recharge (GWR) beneficial use is defined by the *Basin Plan* (RWQCB-LA, 1994) as "uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers." For the Santa Clara River watershed, an existing or potential groundwater recharge beneficial use is listed for all reaches included in this TMDL.

The numeric target to protect groundwater recharge in the TMDL reaches where groundwater discharges to the surface (Figure 4) is the same concentration as the surface WQO, 100 mg/L at the downstream end. The success of the TMDL may require revision of the groundwater objective for chloride of 200 mg/L to 100 mg/L in the basins underlying the impaired reaches.

In the Santa Clara watershed, releases from impounds such as Pyramid, Castaic and Bouquet Canyon reservoirs are used to maintain groundwater levels and support surface discharge to downstream users. These releases rapidly percolate into groundwater. During drought conditions, the conservation releases may contain chloride in excess of the WQO.

2.1.2.3 Rare, Threatened, or Endangered Species Beneficial Use

The Santa Clara River supports unique populations of endangered fish, amphibians, and plant life. Two types of endangered and rare fish are known to reside in the watershed: steelhead trout and unarmored three-spine stickleback fish. Both acute and chronic tolerance for the steelhead trout are nearly one order of magnitude greater than current ambient conditions, so changes proposed by this TMDL may be detrimental to the species only if surface flows are reduced as part of the TMDL implementation plan.

Species-specific acute and chronic tolerance levels to chloride for the unarmored three-spine stickleback are unknown. The armored three-spine stickleback, which is not endangered, is found in brackish and marine settings, but the endangered species exists exclusively in fresher water pools, in tributaries and during flood conditions of decreased salinity in the main stem of the river.

Additional work is required to confirm staff's preliminary findings that indicate that predation, food supply, and habitat may be more critical than salinity (at the reaches under discussion) to the stickleback. This preliminary finding is based on US Forest Service (Forest Service) restoration work for the species during the last decade. The Forest Service made two recent and unsuccessful attempts to relocate the species to similar hydrological and salinity conditions in the Santa Clara River. Variations in predation, food supply and habitat were cited as the cause.

In July or August of 2001 a kill of the endangered stickleback occurred in its critical habitat in Soledad Canyon and was attributed to increased groundwater and surface water extractions (USFS 2001). The loss of habitat did not result directly from water quality changes, but this effect emphasizes how water extraction can cause critical changes in the watershed and cautions against TMDL solutions which may lead to reduced flow.

Other endangered species, such as the Arroyo Toad, Red Legged Frog and supporting riparian species such as the cottonwood, may be sensitive to salinity at higher levels. TMDL remedies, which result in changes in surface flow, may also affect these species.

2.1.2.4 Other Beneficial Uses

WQOs for chloride associated with other beneficial uses such as municipal supply and aquatic habitat are greater than the WQO associated with agricultural supply. Human health and aquatic life are not affected by current ambient conditions, and concentrations have not exceeded the aquatic life guidance value of 230 mg/L or the aesthetic standard of 250 mg/L since 1985. However, current in-river water quality trends and effluent data suggest that the aquatic life standard may be exceeded within the next 5 years without appropriate action (describe in the Implementation Plan, Section 2.6.1)

2.1.3. Antidegradation

State Board Resolution 68-16, *Statement of Policy with Respect to Maintaining High Quality Water in California,* known as the "State Antidegradation Policy," protects surface and ground waters from degradation. Any actions that can adversely affect water quality in all surface and ground waters must be consistent with the maximum benefit to the people of the state, must not unreasonably affect present and anticipated beneficial use of such water, and must not result in water quality less than that prescribed in water quality plans and policies. Furthermore, any actions that can adversely affect surface waters are also subject to the federal Antidegradation Policy (40 CFR 131.12).

Chloride concentrations before 1960 in the Santa Clara River above Blue Cut approximate the existing WQO of 100 mg/L. Between the 1960s and 1980s oil exploration in the Santa Clara watershed and the unregulated discharge of extracted brines produced high chloride levels in the Santa Clara River. Discharge of brines produced during oil exploration was not regulated until after 1975 at which time less drilling occurred and wastewater discharge was restricted.

Chloride levels began to decline after the 1980's, a phenomenon attributed to reduced oil exploration and the increasing use of imported water in the Santa Clara watershed.

Should the Regional Board consider dedesignating the agricultural supply beneficial use for Upper Santa Clara River or modifying the WQO such that it will no longer support the agricultural supply beneficial use, federal anti-degradation policy requires a Use Attainability Study (UAS). Regional Board staff believe that a UAS may not be feasible because the proposed remedies are not predicted to produce substantial or widespread economic impacts according to federal economic measures.

2.2. Development of Numeric Targets

The numeric target is defined as the in-river chloride concentration that will implement the Water Quality Standard. The *Basin Plan* establishes a numeric objective for chloride in Reaches 5 and 6 of 100 mg/L. Consequently, in this TMDL the numeric target is established as 100 mg/L for chloride.

Table 6 summarizes the proposed numeric target for the Upper Santa Clara River chloride TMDL.

TABLE 6. PROPOSED NUMERIC TARGET FOR SANTA CLARA RIVER -CHLORIDE CONCENTRATION

Reach No.	Reach Name	Beneficial Uses	Water Quality Objective (mg/L, measured instantaneously)
5	Blue Cut-Hwy 99	AGR, GWR	100
6	Hwy 99- Bouquet Cyn	AGR, GWR	100

2.3. Source Assessment

The TMDL assesses chloride loading from point sources and nonpoint sources. Point sources typically include discharges for which there is a defined discharge pipe such as wastewater treatment plant discharges or industrial discharges. These discharges are regulated through a National Pollution Discharge Elimination System (NPDES) permit and the state's Waste Discharge Requirements (WDRs). Nonpoint sources by definition include pollutant sources that reach waters from a number of diffuse sources. In the TMDL process, waste load allocations are established for point sources and load allocations are established for nonpoint sources.

2.3.1. Point Sources

Regional Board staff's characterization of the Upper Santa Clara River watershed (RWQCB-LA, 1998) identified two major point source discharges and 10 minor point source discharges in the upper watershed which were permitted under the NPDES program. The two WRPs that discharge into the Upper Santa Clara River are the Valencia WRP and the Saugus WRP, both owned and operated by the County Sanitation Districts of Los Angeles County (CSDLAC).

2.3.1.1 Water Reclamation Plants

The WRP discharges are the largest single source of chloride to the Upper Santa Clara River. The design capacities of the Saugus and Valencia WRPs are 6.5 MGD and 12.6 MGD, respectively. The 1999 average flows were 5.6 and 10.44 MGD with effluent chloride concentrations of 141 and 160 mg/L for the Saugus and Valencia plants, respectively. The total chloride load discharged by the WRPs is approximately 20,600 pounds per day (lbs/day) based on 1999 data. Recent increases in WRP loading are documented. Average monthly chloride concentrations in the WRP effluent for March 2002 were 165 mg/L and 185 mg/L for the Saugus and Valencia WRPs, respectively. Staff believes that the recent increase in chloride effluent is attributable to increases in chloride in source water imported to the Upper Santa Clara River watershed, increases in chloride loading from domestic sources, including self regenerating water softeners, and local drought conditions.

2.3.1.2 Minor discharges

The 1998 report by Kennedy/Jenks listed the minor discharges to the Santa Clara River in 1997. This list is considered sufficiently representative of the average character of minor discharges by Regional Board staff because the discharges change frequently and contribute flow only during a short period of time varying from a day to a few months. Table 7 lists discharge volumes and estimated chloride concentrations from all point sources.

TABLE 7. 1997 DISCHARGE VOLUMES AND CONCENTRATIONS

Permitted Discharges to Reaches 5 and 6	Permitted discharge volume, MGD	Estimated chloride concentration, mg/L
Valencia WRP	10.4*	160**
Saugus WRP	5.62*	141**
CSDLA dewatering	4.9	78***
Calex Engineering dewatering	4.9	78
Textron-GW cleanup	0.1	78
Textron-GW cleanup	0.05	78
LA County Parks swimming pool	0.01	50
Mobil Oil-GW cleanup	0.006	100****
Santa Clara Community College swimming pool	0.275	50
City of Santa Clarita-dewatering	0.14	78
City of Santa Clarita-dewatering	0.6	78
Six Flags Magic Mountain-water rides	0.6	50

*Actual discharge 1999
** 1999 average
*** 1954-1996 average measured at the "Old Valencia" well between Castaic Creek and Valencia
**** Groundwater objective

2.3.2. Nonpoint Sources

Surface and irrigation runoff are examples of non-point source chloride discharges. The average flow from nonpoint sources in the reaches addressed in the TMDL is estimated at 2 cubic feet per second (cfs). This value includes discharges from septic systems, urban runoff, irrigation return flows and leachate to groundwater, rising groundwater and surface runoff. Nonpoint source discharge volumes and estimated or measured chloride concentrations from

1947-98 are listed in Table 8. Existing flood flows, aerial deposition, irrigation and septic sources are assumed to be contained in the groundwater and tributary flows and concentrations quantified in Table 8.

TABLE 8. GROUNDWATER AND TRIBUTARY CONCENTRATIONS AND GAUGED FLOWS 1947-1998**

Measured Source	Wet weather flow, cfs	Chloride concentration, mg/L (DWR, 1993)	Dry weather flow, cfs
Lang (Santa Clara headwaters) 1950-77	1.3	15-60	0.51
Saugus (below dry gap and above first WRP) 1976-77	0.66	44*	0.34
Bouquet Creek 1971-75	0.27	15-148	0.16
Castaic Creek 1947-76	1.9	14-67	0.64

* CSDLAC above all outfalls

** USGS gauges

2.3.3 Chloride Load

The effluent flow rate and chloride concentration indicate that the WRPs are the largest chloride source to the Upper Santa Clara River. Because the goal of this TMDL is to achieve a concentration objective, the relative flows and concentrations of the sources are assessed in addition to the loads. Consequently, reduction of chloride loads from the WRPs is the most appropriate method to address the elevated chloride levels in the Santa Clara River. Details regarding flow and concentration of chloride sources in the Upper Santa Clara River are discussed below.

Flow - The flow most commonly recorded by the United States Geological Survey (USGS) at Blue Cut after 1992 was 26 cfs. Of this mode flow, 96% is attributed to the WRPs (1999 average effluent flow was 25 cfs) and 4% was from other point sources and tributaries, rising groundwater and other non-point sources. Sources such as agricultural leachate and tailwater, non-storm urban runoff, septic discharge, and conservation releases from Castaic Lake, Drinkwater Reservoir, and Bouquet Reservoir recharge groundwater and have limited surface expression. In this source assessment, they are considered as part of the groundwater and tributary contributions.

Except for floods, the highest flow from any individual source is the 1999 annual average of 10.44 MGD (i.e. 16.2 cfs) from the Valencia WRP. The sum of the flows from sources other than the Valencia and Saugus WRPs is less than 5% of the in-river flow of 26 cfs. If winter storms are included, other flows constitute 50% of the annual average flow of 50 cfs in the Upper Santa Clara River at Blue Cut after 1992. Because the chloride concentrations in the WRP effluent are sufficiently elevated, and storm water flows are transient, the other sources do not provide sufficient dilution to discount the WRPs as the major sources of chloride during critical periods.

Concentration - The chloride concentration in the WRP effluent averaged 153 mg/L for 1999, whereas the other point sources had an average chloride concentration of 78 mg/L in 1997. The tributary, groundwater and other non-point source flows are estimated to have an average chloride concentration of 75 mg/L.

In 1999 the highest chloride concentration of any individual source was the annual average of 160 mg/L from the Valencia WRP. The second highest chloride concentration was for Bouquet Canyon, a tributary with measurable flow, where a grab sample collected during summer at low flow had a chloride concentration of 148 mg/L.

Chloride concentrations as high as 200 mg/l were also recorded at Highway 99 before 1990, but are attributed to oil field discharge of brines, a discontinued practice. The concentrations above 120 mg/L at Highway 99 have decreased in frequency after 1975 and have a normal distribution, suggesting an anthropogenic chloride source. Additional discussion is included in appendix 2.

Load- The total chloride load estimated in the Upper Santa Clara River is 29,000 lbs/day for 1999 (based on Blue Cut gauged annual average of 50 cfs in 1996 and measured annual average of 109 mg/L in 1999) as described below. The WRP effluent contributes 71.1%

or approximately 20,631 lbs/day. The WRP effluent, with an average concentration of 153 mg/L as quantified in NPDES reports, contributes 24.8 cfs. The tributary, groundwater and other non-point source flows contribute 2.8% or 813 lbs/ day. The water entering the river at Saugus above the Bouquet Canyon Bridge is 0.5 cfs as calculated from average values measured by the USGS between 1946 and 1998. Other tributary flows for the period are added and were gauged at 1.3 cfs from Castaic Creek and 0.21 cfs from Bouquet Canyon for a total average flow of 2.01 cfs. Regional Board staff estimate the chloride concentrations, which vary from 14 mg/L to 148 mg/L, have an annual average of 75 mg/L.

Estimation of the chloride load from minor discharges is difficult due to limited data. Consequently, staff estimated loads from minor discharges based on design flows, estimated discharge concentrations, and an assumption of continuous discharge. Because the flows are known to be less than the design flow and the discharges are known to take place during construction periods, which are usually less than a full year, loading estimates of minor flows are considered to be conservative.

The chloride load from minor discharges is estimated to be approximately 6,602 lbs/day. This load is 22.8% of the total chloride load of 29,000 lbs/day to the Upper Santa Clara River. It is based on an annual average concentration of 72 mg/L including dewatering operations and swimming pool and amusement ride flushes. The flow of 17 cfs is likely overestimated, as it is based on the sum of the permitted flows.

The identified loads (point, non-point, tributary and groundwater) equal 96.7% of the measured average annual chloride discharge at Blue Cut, of which 73.5% comes from WRPs. The remaining 3.3 % of the chloride load is attributed to the absence of gauged flow data for 1999 and annual variations in groundwater, tributary, nonpoint and minor point source flows.

2.4. Linkage Analysis

This section describes the linkage of chloride sources to water quality impacts. Regional Board staff used a statistical approach to correlate chloride sources with the in-river chloride concentration in Reaches 5 and 6. The statistical analysis identified the independent variables in the hydrological system in order to develop a predictive correlation for chloride concentrations ineach reach and the WRP effluent. The in-river water quality data set was modified to account for seasonal effects and account for the effects associated with varying groundwater discharge and evaporation throughout a reach and historical practices such as oilfield brine disposal in the Santa Clara River watershed.

Statistical methods were employed in previous analyses by the Department of Water Resources (DWR) in 1993 and Kennedy/Jenks in 1998. These studies did not quantify changes in in-river water quality related to anthropogenic effects because seasonal variations were found to be extensive (DWR, 1993) and changes in quality due to groundwater and evapotranspiration effects were poorly understood (Kennedy/Jenks, 1998). More advanced hydrodynamic and water quality modeling would also be constrained by these problems and therefore was not used in this TMDL. The Implementation Plan includes development of a hydrodynamic model to develop a site-specific chloride objective, if required.

2.4.1. Model Development

The relationship between the in-river water quality and the chloride loading was evaluated. Of the multiple variables that could affect water quality and be evaluated statistically, those most likely to be independent variables were identified using a simple model of the ground and surface water interactions in the vicinity of Highway 99 and Blue Cut (Figures 6 and 7). The model indicates that the in-river chloride concentrations at Highway 99 and Blue Cut are determined by the concentration and flow of both upstream surface water and discharged groundwater.

Staff evaluated variables that were represented by an extensive data set, including extensive data from the summer because seasonal variations were analyzed by examining chloride in impaired reaches during the driest six months of the year. Finally, the variable had to be measured at the end of the reach because the hydrological variations attributed to groundwater and evapotranspiration effects throughout a reach are complex. The analysis focused on the cumulative effect of these variations by assessing the downstream end of each impaired reach.

The independent variables evaluated are identified in Figure 7 and described below. The details of the statistical steps used to identify these variables are included in Appendix 2.The following summarizes the key conclusions of the linkage analysis:

A. The Valencia and Saugus WRP effluent concentrations and flows were identified as independent variables relative to the natural system.

B. The differences between the Valencia WRP monthly average effluent chloride concentration and the Blue Cut chloride concentration for May through October between 1971 and 2000 were found to be log-normally distributed. The differences were found to correlate with the Valencia WRP monthly average effluent chloride concentration and the differences had a better correlation to the effluent concentration than the Blue Cut chloride concentration alone. This combination of statistical tests identified the chloride concentration difference between the WRP effluent and the in-river concentration at the end of each reach as an independent variable. The data collected between 2000 and the date of the report were added to the analysis for both locations without substantial change in the results.

C. The Saugus WRP monthly average effluent chloride concentration minus the Highway 99 concentration, for Highway 99 values less than 120 mg/L between 1971 and 2000, were studied. The differences were found to be log-normally distributed. The differences described were found to have a limited correlation with the Saugus WRP monthly average effluent chloride concentration. Finally, the Saugus WRP monthly average effluent chloride concentration minus the Highway 99 concentration for Highway 99 values greater than 120 mg/L between 1971 and 2000 was found to be normally distributed. This combination of statistical tests and A and B lead staff to identify the difference for Highway 99 values less than 120 mg/L as an independent variable.

The log-normal distribution of the difference between the in-river and the upstream WRP effluent chloride concentrations and the relationship of that difference to the effluent concentration make these parameters good candidates for a statistical assessment predicting the results of the TMDL. Other hydrologic parameters were not found to be related in a statistically valid manner or did not characterize variables that were useful in predicting the effect of TMDL remedies.

The statistical analysis leads to the conclusion that the ability of the natural system to dilute the effluent flows is an independent variable. This is consistent with hydrological conditions because ground and surface waters at the downstream end of the impaired reaches are known to contain effluent and the contrast between the effluent concentrations and water quality appears to be more predictable when variations in the effluent concentration are removed by considering the difference between the effluent and concentrations at the end of the reach.

2.4.2. Application of the Model

The statistical relationship between the largest chloride source and the water quality in the Santa Clara River was used to predict the water quality after the application of TMDL remedies. This section describes the basis for the MOS determinination in this TMDL. Prediction and management of concentration effects during critical conditions with historical frequency has adequate precision using the statistical model, assuming that existing groundwater concentrations and flows are maintained.

The assimilative capacity of the river varies at different locations within each reach. Specifically, at the critical condition of drought or summer flow, the flowrate of the Upper Santa Clara River is equivalent to WRP effluent flow plus groundwater discharge plus conservation releases from reservoirs (staff observations 1999, 2000, 2001). Because the chloride objective applies throughout Reaches 5 and 6, the target must be met at locations characterized by the largest chloride load and lowest assimilative capacity, and especially in the vicinity of the WRP outfalls.

Ninety percent of the differences measured between the average monthly effluent chloride concentrations and the water quality samples taken at Blue Cut measured 16 mg/L or more (Figure 8). Similarly, 90% of the differences measured between the average monthly effluent discharge between samples measured at Highway 99 and effluent concentrations measured 14 mg/L or above (Figure 9). These observations show that a chloride concentration in Valencia WRP effluent of 116 mg/L and in Saugus WRP effluent of 114 mg/L (or 117 mg/L using the most recent data) were associated with a chloride concentration of 100 mg/L or less at Blue Cut and Highway 99, respectively.

Additional hydrological modeling to determine assimilative capacity is recommended in the Implementation Plan. Appendix 2 provides additional details regarding the linkage analysis.

2.5. Waste Load Allocations

The chloride loads necessary to attain water quality standards were allocated among the existing sources. As discussed in the source analysis, the WRP effluent was identified as the largest source of chloride loading. The proposed allocation strategy limits the chloride contributed to the Santa Clara watershed from WRPs.

The reduction in chloride load from WRP effluent required to attain the WQO and numeric target is accomplished by limiting the chloride concentration in WRP effluent to 100 mg/L. As discussed in Section 2.5.4, an explicit margin of safety (MOS) is not proposed for the WRP effluent limit. The chloride load allocation corresponding to the 100 mg/L numeric target for the Saugus and Valencia WRPs, based on design flowrates, are 5,421 lbs./day and 10, 506 lbs./day, respectively. Additional discussion of the MOS are provided in section 2.5.4. Wasteloads are not allocated to minor NPDES discharges because the chloride load associated with these discharges is relatively small.

Potential remedies could increase the available assimilative capacity of the Upper Santa Clara River. The Regional Board will consider alternative allocations that may be negotiated among stakeholders, if those allocations are expected to succeed in meeting WQOs for impaired reaches.

2.5.1. Load

The linkage analysis shows that a waste load allocation expressed as a concentration based effluent chloride limit from the WRPs discharge of 100 mg/L will effectively achieve the WQO for chloride throughout the impaired reaches. The linkage analysis shows that based on an effluent discharge limit of 100 mg/L chloride, the concentration at the bottom of Reaches 5 and 6 are 84 mg/L and 83 mg/L, respectively.

2.5.2. Growth

The concentration limit allows for growth with source reduction or effluent treatment. A concentration-based target accommodates future growth by allowing increased mass as long as it is accompanied by additional flow. This analysis is based on the existing discharge locations in the Upper Santa Clara River. Regional Board staff understands that an additional water reclamation plant is planned to accommodate future growth in the Santa Clarita Valley and that this plant will discharge only during rain events. Permitting of additional discharges may compromise the success of the TMDL without additional studies.

Further, the analysis demonstrates that changes in the existing groundwater conditions and flows have the potential to prevent the success of the concentration limit proposed in this TMDL. Specifically, large off-river discharges such as those which may occur from major permitted waste treatment systems into a percolation pond or a reclaimed water system in the immediate vicinity of the impaired reaches could remove diluting effects through local or temporary increases in groundwater concentrations through direct percolation or leaching. Further, increased groundwater extraction or diversion could similarly remove flows necessary to dilute permitted discharge. These effects would be especially prominent during drought.

2.5.3. Critical Conditions and Seasonality

The statistical approach used a sufficiently long record of water quality data in the river such that the full range of critical conditions and seasonality were represented. Three critical conditions are identified for this TMDL. The driest six months of the year are the first critical condition for chloride because less surface flow is available to dilute effluent discharge, pumping rates for agricultural purposes are higher, groundwater discharge is less, poorer quality groundwater may be drawn into the aquifer and evapotranspiration effects are greater in warm weather (Kennedy/Jenks, 1998). If drought conditions continue through several seasons, the second critical condition of reduced surface flow and increased groundwater extraction may exist, characterized by a greater impact on groundwater resources and discharge (USGS, 1992). The third critical condition occurred in 1999, a year of average flow, when 9 of 12 monthly averages exceeded the objective (Resolution 00-20). Data from all three critical conditions were used in the statistical model described.

The model used for the TMDL predicts compliance under each of these conditions with the frequency they occurred in the historical record between 1975 and 2000. The modeled conditions included the California-wide drought between 1986 and 1992.

2.5.4. Margin of Safety

Clean Water Act Section 303(d) requires a Margin of Safety (MOS) to account for uncertainties in the TMDL analysis. The required MOS may be provided explicitly by reserving (not allocating) a portion of available pollutant loading capacity and/or implicitly by making conservative analytical assumptions in the supporting analysis. This TMDL provides an implicit MOS.

This TMDL uses conservative analytical assumptions in the supporting linkage analysis and therefore does not propose an explicit MOS applied to the numeric target of 100 mg/L for

Reaches 5 and 6. Consequently, the numeric targets for discharge limits are 100 mg/L at the Valencia WRP and Saugus WRP. These discharge limits are estimated based on available data that are considered insufficient to support the recommendation of a site-specific objective at this time. Further studies would be required during the Implementation Period to provide supporting evidence ensuring the protection of all beneficial uses before a WQO amendment or site-specific objective can be considered. Table 9 summarizes the WLA based on the water quality objectives.

TABLE 9. NUMERIC TARGET AND CALCULATION OF DISCHARGE LIMIT (WLA) WITH EXPLICIT MARGIN OF SAFETY

Location	In-river Chloride Numeric Target, mg/L	Final Discharge Limit mg/L (WLA)
Reach 5	100	Valencia WRP 100
Reach 6	100	Saugus WRP 100

Table 10 summarizes the technical factors associated with the implicit MOS. As described in Section 2.5.1, the linkage analysis indicates that an explicit MOS is not required for the numeric target in this TMDL. The linkage analysis and statistical model demonstrate that assimilative capacity and the implicit MOS is suffficient to attain the chloride WQO and provide a 10-17% MOS in 90% of the predicted in-stream water measurements under the most critical conditions in the vicinity of existing point discharges.

TABLE 10. SOURCES OF UNCERTAINTY AND IMPLICIT MOS PROVISIONS

Source of Uncertainty	Implicit MOS Provisions
Chloride concentrations show great seasonal and annual variations.	Long record of historical data used to calculate numeric target averages out annual variations. Further, only the critical summer season is evaluated where possible, eliminating the effects of some seasonal influences
Available data are limited in quantity and quality.	All available data were used for the TMDL.
Water softeners, growth may add load.	Increased loading to the waste dischargers could result from an increase in the urban population, or a greater market penetration of self-regenerating water softeners. The cost associated with the remedy necessary for the higher chloride concentrations may increase as a result of these factors, but they do not change the assimilative capacity of the river nor the recommended discharge requirements
Water Rights and Groundwater Pumping: Several surface water rights decisions for Santa Clarita area are pending.	TMDL assumes existing utilization of the groundwater flows present, which is equivalent to the safe yield estimated by numerous sources. This suggests that higher groundwater extraction rates cannot be sustained. Continuing and future monitoring and re-examination of the success of the TMDL may provide some protection against increased extraction volumes.

Source of Uncertainty	Implicit MOS Provisions
The average of the in-river chloride concentrations vary throughout the reach as a function of the proximity to the WRP discharge points.	By setting the numeric target equivalent to the chloride WQO througout Reaches 5 and 6, the TMDL utilizes additional assimilative capacity provided by groundwater discharge to ensure that water quality standards are attained.

*Slade, 1983 and Santa Clarita Valley Report 1998 describe average safe yield for the alluvial aquifer as 32,500 acre-foot/year, a value exceeded in pumping after 1993 by water purveyors in the upper Santa Clara Valley as reported in 1998

Alternative methods of applying an explicit MOS are described in Appendix 3. A final numeric target and MOS which do not result in attainment of 100 mg/l measured instantaneously everywhere in these reaches will require the development of a Basin Plan Amendment or a site-specific objective. As discussed in the Implementation Plan, the additional studies leading to a *Basin Plan* Amendment or site specific objective may be developed within three years after the effective date of this TMDL and may result in alternative remedies or modifications to the recommendations of the TMDL.

2.6. Implementation

California Water Code section 13360 precludes the Regional Board from specifying the method of compliance with waste discharge requirements; however California Water Code section 13242 requires that the *Basin Plan* include an implementation plan to describe the nature of actions to be taken and a time schedule for action. This implementation plan contains additional studies to be conducted by County Sanitation Districts of Los Angeles County to refine estimates of assimilative capacity and chloride requirements for irrigation of sensitive agriculture and two options to attain compliance with the WQO for chloride in the Upper Santa Clara River: source reduction and WRP effluent treatment to remove chloride. The implementation plan includes additional studies and a time schedule to determine if sufficient chloride reduction can be achieved through source reduction methods and to evaluate the second alternative, construction of a chloride removal treatment system, such as reverse osmosis and brine disposal, if the source reduction methods are not effective.

- Task I: Upper Santa Clara River (SCR) Groundwater/Surface Water Interaction Model

Task I involves the development and calibration of a peer-reviewed groundwater/surface water interaction model for Reaches 5 (West Pier Hwy 99 to Blue Cut Gauging Station) and 6 (Bouquet Canyon Bridge to West Pier Hwy 99) by CSDLAC in cooperation with the Regional Board. The purpose of this model is to determine the assimilative capacity of chloride in Reaches 5 and 6, the impact of changes in groundwater levels and concentrations, and to determine the impact of reclaimed water application in the watershed.

The subtasks involved in Task I include:

- soliciting requests for proposals from qualified modeling firms;
- collecting available historical surface water and groundwater quality data, and if needed conduct additional monitoring;
- collecting appropriate geological/hydrological data for modeling, and if needed conduct additional monitoring;
- model development and calibration by CSDLAC in cooperation with the Regional Board
- third-party scientific peer review of the model; and
- preparation of an assimilative capacity report, discussing model results.

Two years from the effective date of the Chloride TMDL is estimated to be required to complete the subtasks outlined above. The results from this process will be utilized in Tasks V and VII, discussed in more detail in the sections that follow.

➢ Task II: Chloride Source Identification/Reduction, Pollution Prevention and Public Outreach Plan

Task II involves the development and implementation of a chloride source identification/reduction, pollution prevention and public outreach plan for the Santa Clarita Valley (SCV) by CSDLAC. The purpose of Task II is to identify all sources of chloride entering the Santa Clarita Valley Joint Sewerage System (SCVJSS), to determine appropriate source reduction measures that can be taken to reduce chloride loading into the SCVJSS, and to implement those measures determined to be most effective.

Task II involves the following subtasks:

- quantification/identification of the chloride sources in the SCVJSS;
- development of a pilot-scale outreach and education program on sources of chloride for targeted areas of the SCV;
- assessment of pilot-scale effectiveness for development of regional-scale outreach and education programs on sources of chloride;
- development and implementation of appropriate chloride source reduction, pollution prevention and public outreach/education programs for the SCVJSS; and
- preparation a report summarizing efforts and including a discussion of their effectiveness

Task II is scheduled concurrently with Task I and will require approximately two years from the effective date of the Chloride TMDL to complete the subtasks outlined above. Appropriate programs will be continued beyond this two-year time frame as needed to minimize chloride loadings to the SCVJSS.

- Task III: Evaluation of Alternative Water Supplies for Agricultural Beneficial Uses

Task III involves an evaluation of providing alternative water supplies by CSDLAC for agricultural users of surface water from the Upper Santa Clara River, who grow avocados or other sensitive crops downstream of the Valencia WRP in the upper portion of Reach 4, between Blue Cut and Piru Creek. The purpose of Task III is to identify the use of suitable and feasible alternative irrigation water supplies for point of use application, whereby a cost-effective long-term water supply option for the off-stream agricultural beneficial use for sensitive crops can be determined. As noted in Section 2.6.1, Interim Limits, exceedance of the proposed interim discharge limit will require immediate actions to provide alternative water supplies to agricultural users during the implementation period of this TMDL.

Task III includes the following subtasks:

- quantification of the water supply needs and locations where needed;
- identification of suitable and feasible alternative water supplies for agricultural irrigation;
- evaluation of conveyance and/or other needed facilities for those alternative water supplies identified in subtask (2); and
- preparation of a report identifying and discussing the feasibility of utilizing alternative water supplies.

Task III is scheduled concurrently with Task I and Task II, and it is estimated that Task III will require two years from the effective date of the Chloride TMDL to complete the subtasks outlined above.

➢ Task IV: Evaluation of Appropriate Chloride Threshold for the Protection of Sensitive Agricultural Supply and Endangered Species Use

Task IV involves an evaluation of recent field studies performed (such as the Akko, Israel and Escondido and Covey Lane studies) by a Technical Advisory Committee funded by CSDLAC to determine an appropriate chloride threshold for the protection of avocados, the most sensitive beneficial use in the watershed and/ or to determine the chloride sensitivity of endangered species. Task IV is needed to determine if field work performed in the 1990's can be evaluated to understand the linkage between chloride concentrations and their effect on crop yields and to calculate a revised water quality objective based on that information, if appropriate.

The subtasks involved in Task IV include:

- the convening of a technical advisory committee (TAC), comprised of agricultural and water quality criteria experts and the Regional Board, to evaluate the state of the science and field work discussed previously and of technical advisors on endangered species and the Regional Board;
- TAC review of the literature and available studies;
- TAC development of a methodology for evaluating the chloride threshold for the protection of avocados and calculation of a water quality objective and the sensitivity of endangered species;

- if needed, design and implementation of additional studies and/or analyses for the development of an appropriate chloride threshold; and
- preparation of a technical report summarizing TAC findings and recommendations.

Task IV is scheduled concurrently with Task I, Task II, and Task III and it is estimated that Task IV will require two years from the effective date of the Chloride TMDL to complete the subtasks outlined above. Additional studies may or may not be necessary if the TAC finds that the evaluations from available studies (i.e. Akko, Escondido and Covey Lane) are sufficient and further studies and/or analyses are not needed. If additional studies are deemed necessary, however, based on the scale of additional studies required, the time frame for the completion of Task IV could take as long as 4 – 6 years from the effective date of the chloride TMDL. As such, a time frame of 3 years is recommended with a re-opener to expand the time frame to 4-6 years, if the TAC and the Regional Board recommend that a larger-scale study is required for this task. It should be noted that an expansion of the time required to complete Task IV (from 3 to 6 years), would affect other contingent tasks accordingly.

- Task V: Development of Site Specific Objective (SSO) for Chloride for Sensitive Agriculture (If Applicable)

Task V involves the development of a SSO for chloride for sensitive agriculture based on the recommendations from the TAC in Task IV, after considering the assimilative capacity of the watershed with respect to chloride (Task I). It is estimated that Task V will require 1 year from the finish of Tasks I and IV, or be completed 3 years from the effective date of the Chloride TMDL. It could be possible that Task V is not applicable, if the results from Tasks I and IV do not warrant that an SSO for chloride in Reaches 5 and 6 is necessary. Task V has no defined subtasks. The allotted time frame includes time required for a formal RFP process to select a qualified consultant. The SSO would be developed for Regional Board to utilize in the preparation of a Basin Plan amendment for Regional Board consideration.

A SSO would be effected as a *Basin Plan* amendment. This entails developing a staff report describing the rationale for the proposed SSO and tentative resolution for amendment of the Basin Plan, noticing a public hearing in which the Regional Board will consider adoption of the tentative Basin Plan amendment, and filling out a CEQA checklist. If the Regional Board adopts the tentative Basin Plan amendment, the SSO will become effective after the Basin Plan amendment is approved by the State Water Resources Control Board and Office of Administrative Law, and established by the USEPA.

- Task VI: Development of Anti-Degradation Analysis for Revision of Chloride Objective by SSO Evaluation (If Applicable)

Task VI involves the development and preparation of an anti-degradation analysis (if applicable). Task VI is contingent on whether an SSO for chloride at a higher level than the current chloride objective is recommended in Task V. It is expected that Task VI will be worked on in parallel with Task V and will require 1 year from the finish of Tasks I, III and IV, or be completed 3 years from the effective date of the Chloride TMDL. Task VI has no defined subtasks, as this Task will likely be completed by a consulting firm with expertise in preparing an anti-degradation analysis for Regional Board approval. The allotted time frame includes time required for a formal RFP process to select a qualified consultant.

- Task VII: Los Angeles Regional Water Quality Control Board (Regional Board) Preparation and Adoption of *Basin Plan* Amendment (BPA) for Chloride Objective (if Applicable)

Task VII involves the Regional Board staff preparing a BPA (if applicable) for the surface water chloride objective for Reaches 5 and 6 of the SCR. Task VII is contingent on the outcomes of Tasks V and VI (development of the SSO and anti-degradation analysis). It is estimated that Task VII will require 6 months from the finish of Tasks V and VI, or be completed approximately 4 and years from the effective date of the

Chloride TMDL. Upon adoption by the Regional Board, the BPA must also be reviewed and approved by the State Water Resources Control Board (SWRCB), Office of Administrative Law (OAL) and U.S EPA, Region IX, which is estimated to take approximately one year from the adoption of the BPA.

- Task VIII: Regional Board Modification of Chloride TMDL (if Applicable)

Task VIII involves the Regional Board's modification of the chloride TMDL based on the approval of the BPA for chloride (Task VII) and the assimilative capacity model developed in Task I. It is expected that a modification of the chloride TMDL will require approximately 6 months from the finish of Task VII, or be completed 4 years from the effective date of the Chloride TMDL by the Regional Board. Once the Regional Board adopts the revision of the Chloride TMDL, the Saugus and Valencia WRP NPDES permits would need to be revised accordingly. Upon adoption by the Regional Board, the revision to the Chloride TMDL must also be reviewed and approved by the SWRCB, OAL and USEPA, Region IX, and this process is estimated to take approximately one year from the adoption of the revised Chloride TMDL.

- Task IX: Analysis of Feasible Compliance Measures to Meet Load Allocations from Revised TMDL

Task IX involves an analysis of all feasible options to meet final (revised) chloride permit limits, including an analysis of compliance alternatives (such as providing an alternative irrigation water supply), based on the results of Tasks I-VIII. The ultimate compliance measures taken will be contingent on the outcome of Task VIII, the success of ongoing public outreach and education programs (Task II) to reduce chloride loadings, and the results of Task III. It is estimated that all appropriate compliance measures to meet final effluent chloride permits limits will be identified approximately 1 year from the finish of Task VIII, or 5 years from the effective date of the chloride TMDL. This task will include the preparation of a report summarizing compliance options (including associated technical assessments and costs estimates).

➢ Task X: Planning, Design and Construction of Advanced Treatment Facilities (If Necessary)

Task X involves the planning, design and construction of microfiltration (MF) and reverse osmosis (RO) facilities as well as a 43-mile brine line and ocean outfall (conveyance facilities) by CSDLAC, if it is determined that the construction of these advanced treatment facilities is necessary to meet final effluent permit limits for chloride. It is estimated that eight years from the finish of Task IX, or 13 years from the effective date of the chloride TMDL, are required to complete Task X.

Task X involves the following subtasks:

- preparation of CEQA related planning documents (i.e. Facilities Plan and Environmental Impact Reports/Statements)
- obtaining permits and conducting required regulatory consultations (e.g. Army Corps of Engineers, U.S. Fish & Wildlife Service, National Marine Fisheries Service) for the planning and construction of MF/RO and conveyance facilities;
- identifying needed land acquisitions / easements and securing the financing and necessary approvals for the project;
- design of MF/RO and conveyance facilities; and
- construction of MF/RO and conveyance facilities.

2.6.1. Interim Limits

The implementation plan proposes that during the period of TMDL implementation, compliance for the WRP effluent will be evaluated in accordance with interim limits based on 2000 - 2001 performance (*i.e.*effluent chloride concentration at the Valenica and Saugus WRPs). Using the USEPA protocol described in Table 5-1 of the Technical Support Document for Water Quality-based Toxics Control (USEPA, 1991), the average monthly interim limits are 200 mg/L and 187 mg/L, and the maximum daily limits are 218 mg/L and 196mg/L for the Saugus and Valencia WRPs, respectively.

In addition to the proposed interim effluent limits above, the WRP effluent and in-river chloride concentrations cannot exceed the chronic criteria for chloride for protection of aquatic life during the implementation period. The EPA defines this limit for freshwater species in

Ambient Water Quality Criteria for Chloride (1988) as 230 mg/L not to be exceeded more than once every three years on average. Should this concentration be exceeded more than two times in a three year period, the discharger shall be required to submit a work plan within ninety days for an accelerated schedule to reduce chloride discharges.

Further, the effluent discharge and the in-river chloride concentrations cannot be allowed to impair the downstream agricultural beneficial uses. Should the monthly average in-river concentration at Blue Cut, the reach boundary, exceed the water quality objective of 100 mg/L, measured as a rolling twelve month average, for three months of any 12 months, the discharger will be responsible for providing an alternative water supply that meets the irrigation requirements of Camulos Ranch until such time as the in-river values do not exceed the water quality objective.

2.6.2. Source Reduction Remedies for Reduction of Municipal Waste Discharge

Source reduction programs to eliminate chloride in the effluent and water sources provide a cost effective method of meeting the TMDL requirements. The Source Assessment and Linkage Analysis show that WRP discharge is the largest contributor of chloride in the watershed. Options for reducing the WRP contribution include alternative disinfection methods, reducing the urban waste load, and reducing the load in the source water. In addition, the effects of newer, high efficiency self-regenerating water softeners need to be quantified to determine if these types of units can provide effective chloride source reduction. The estimated impact of chloride source reduction methods is described below. Table 11 estimates the water quality effects of source removal methods during non-drought conditions based on an assumed effluent concentration of 130 mg/L, which was characteristic before the recent drought conditions.

TABLE 11. NON-DROUGHT SOURCE REDUCTION REMEDIES AND THE CALCULATED EFFECT ON THE EFFLUENT CONCENTRATION

Source Reduction Remedy	Process	Reduction in mg/L	Estimated Effluent concentration
No Source reduction			130 mg/L
Elimination of chlorine disinfection of waste	Ultraviolet or ozone treatment	5-15 mg/L	115 – 125 mg/L

Source Reduction Remedy	Process	Reduction in mg/L	Estimated Effluent concentration
Prohibitions on chlorine soaps and products	Education on alternative products	5-10 mg/L	105 – 120 mg/L
Voluntary replacement of self-regenerating water softeners with canisters	Education, rate adjustments and/or rebates for existing water softener users	25 mg/L	80 - 95 mg/L
Non-Drought Effluent			80 – 95 mg/L

Table 12 estimates the water quality effects of source removal and water conservation methods during drought conditions based on an assumed effluent concentration of 140 mg/L. The assumed average effluent concentration during drought conditions is based on an imported water concentration of 105 mg/L and a chloride concentration increase due to residential loading of 35 mg/L.

TABLE 12. DROUGHT PLUS NON-DROUGHT SOURCE REDUCTION REMEDIES AND THE CALCULATED EFFECT ON THE EFFLUENT CONCENTRATION

Drought Source Reduction Remedy	Process	Reduction in mg/L	Effluent concentration
Non Drought Source Reduction			140mg/L
Voluntary drought shut-down of self-regenerating water softeners	Education, rate adjustments and/or rebates for water softeners	10 mg/L	130mg/L
Reduction in imported water use	Conservation and less irrigation	7-20 mg/L	110 – 123 mg/L
Alternative water supply sources for use in drought	Replace 105 mg/L imported water with groundwater at 100 mg/L and aquifer storage recovery water at 50 mg/L	30 mg/L	80 - 97 mg/L
Final Drought Effluent			80-97 mg/L

The remedies may be sufficient to eliminate 50 mg/L in non-drought and over 100 mg/L in drought conditions. If source reduction methods are effective, they may eliminate the necessity WRP effluent treatment to meet the numeric target for chloride. Appendix 4 contains further details on source reduction methods.

2.6.3. Reverse Osmosis Treatment and Brine Line Construction

If source reduction programs do not prove effective in eliminating chloride impairments, advanced treatment of WRP effluent could meet the requirements of the TMDL. Advanced treatment entails installation of a chloride removal system such as reverse osmosis to remove chloride from WRP effluent, in-river flows, or pumped groundwater. The advanced treated wastewater would be mixed with secondary-treated effluent before discharge to the river at proportions that will meet discharge requirements of this TMDL. The high-salinity waste stream from the reverse osmosis process would be discharged directly to the Pacific Ocean in a conveyance known as a “brine line.” Construction of this pipeline, ocean outfall, and the reverse osmosis system requires advance planning and design, acquisition of right-of-way, subsurface pipe installation and plant construction.

Reverse osmosis treatment utilizes a pressure gradient across a semi-permeable membrane that precludes transmission of chloride while allowing transmission of water. The process can effectively reduce chloride concentrations to as low as 10-20 mg/L. It is estimated that the numeric objective for chloride concentration in the effluent can be attained by blending a portion of the WRP effluent that has been treated by reverse osmosis with the remaining WRP effluent. The minimum estimated discharge load with treatment of a WRP load of 21,000 lbs/day would be 1,500 lbs/day. Based on 1999 load estimates without source reduction, staff estimates approximately 25-50% of the WRP effluent would need to be treated by reverse osmosis to attain a WQO of 100 mg/L, depending on source water quality.

The reverse osmosis system also would have the added benefit of removing many other contaminants to be addressed by TMDLs in the next ten years including nitrate, nitrite, total dissolved solids, sulfates, and organic pollutants such as those contained in pesticides and human health products.

2.6.4. Schedule

The implementation of this TMDL is staged to meet the time requirements of construction of the more costly remedy should source reduction remedies prove ineffective. The implementation schedule is presented in Figure 10. It is noted that Figure 10 is referenced to the Regional Board adoption of the TMDL rather than effective date of the TMDL (i.e. after approval by State Board, Office of Administrative Law and U.S. EPA). Regional Board staff estimate that approval by State Board, USEPA and Office of Administrative Law will take one year from the TMDL adoption by Regional Board.

2.6.5. Monitoring

Existing and additional monitoring will be implemented to verify the effectiveness of the TMDL remedy. The WRP effluent concentrations specified by this TMDL are expected to achieve the specified WQOs and support designated and observed beneficial uses in the waterbody. Monitoring to test the success of the TMDL will be included in the WRP's NPDES permits. In addition, it is recommended that the stakeholders collaborate to prepare an enhanced monitoring agreement for the upper watershed during the first two years of the implementation plan.

2.6.6. Enforcement

Compliance with the TMDL requirements will be attained through the existing NPDES program for the two major WRPs (Saugus and Valencia) discharging to the Upper Santa Clara River.

2.7. Economics

Regional Board staff analyzed the costs of source reduction and effluent treatment programs to reduce the chloride loading to the Upper Santa Clara River. The cost analysis for source reduction is based on the estimated costs for implementing a program to replace self regenerating water softeners (SRWSs) in the Santa Clarita Valley with cartridge water softeners. The cost analysis for effluent treatment is based on a 10 MGD treatment facility to remove chloride and other salts from the WRP effluent and construction of a line to dispose the salts in the ocean. The cost analysis concludes that the costs for source reduction will have a minor impact on current sewage rates in Santa Clarita, whereas the costs for effluent treatment will increase these rates to a level above the California average sewer rate.

2.7.1. Costs

This section presents cost estimates for source reduction and effluent treatment programs.

2.7.1.1 Source Reduction

The cost estimate of the source reduction program is based on the costs for a program to provide an incentive to residential users to replace their SRWSs with cartridge type water softeners. The program is designed to reduce the chloride loading by approximately 6,200 lbs. per day, approximately 33% of the chloride load in the Upper Santa Clara River. The following factors were used to estimate costs for source reduction:

- Incentive program of $1,000 by CSDLAC per water softener replaced.
- 60,000 total connections in Santa Clarita, with an estimated at least 9,000 self regenerating water softeners based on studies in other communities with high salinity source water.
- Removal of approximately 20 lbs. salt per month per SRWS.
- 9,000 water softeners in Santa Clarita area represents 15% of the total connections in Santa Clarita. Chloride reduction approximates 6,200 lbs/day (20 lbs. per month X 30 days/month X 0.6 lbs. chloride/lb. salt)
- Financed at 3% and 7% over 20 years
- $250,000 per year administration costs for the chloride reduction program.

The estimated costs are summarized on Table 13.

TABLE 13. COST SUMMARY FOR SOURCE REDUCTION

Source Reduction Financing Options	Annualized Costs	Costs per Connection
3% Interest Rate, 20 year term	$1,258,000/year	$1.75 per month
7% Interest Rate, 20 year term	$1,666,000/year	$2.31 per month

2.7.1.2 WRP Effluent Treatment

The costs associated with this TMDL for effluent treatment are summarized on Table 14 and include: advanced treatment for chloride removal from WRP discharge; and discharge of brines produced by chloride removal to the ocean. The basis of the cost estimates is also summarized on Table 14. Table 14 summarizes the cost estimate basis for effluent treatment for WRPs in the Calleguas Creek Watershed by the Calleguas Municipal Water District (CMWD), and cost estimates for the Upper Santa River by the Regional Board (RWQCB) and the County Sanitation Districts of Los Angeles County (CSDLAC).

TABLE 14. COMPARISON OF COSTS FOR BRINE LINE WITH OCEAN OUTFALL

Brine Line with Ocean Outfall	Influent mg/L	Size MGD	% Treated	Peaking factor	Capital in $Million	Source	Capital cost $MM /MGD	Note
Calleguas	150-200	10	100		120	CMWD	12	
Valencia + Saugus (Santa Clara)	190	10	100	1.5	125	RWCQB	12.5	2001 demand
	190	40	100	2.3	300	CSDLAC	7.5	2050 demand

Staff's cost estimate for a reverse osmosis facilities and a pipeline with an ocean outfall is approximately $125 million based on similar facilities and pipeline in the Calleguas Creek watershed. County Sanitation Districts of Los Angeles County (CSDLAC) estimate the cost of $300 million. The difference in the estimates arises as CSDLAC's uses different assumptions, including a designed brine line that is larger than the Regional Board's estimate and sized for growth over the next 50 years. A proposal for a brine-line in the adjacent Calleguas Creek Watershed has been developed with the participation of the stakeholders at a reported cost of $120 million.

Annualized costs are based on the capital cost estimate of $125 million and an estimated cost for operations and maintenance of $5 million per year. Amortizing the capital costs at 3% per year for 20 years and adding that amortized cost to the annual operation and maintenance costs yields an annual cost estimate of $18.61 per month per connection for the effluent treatment remedy. Total sewage rates of $29.57 per month are estimated for the treatment option, compared to current rates of $10.96 per month.

2.7.2. Affordability

The costs of applying the TMDL remedies ranges from a minor rate increase for the source reduction remedies to a rate increase to above the California average for effluent treatment. Table 15 indicates sewage rates for major cities in California and allows comparison of the costs of TMDL implementation to the current monthly household sewer rates. The estimated sewage rates that would result from most expensive TMDL remedy are above the average in California, which is $19.82 for 2001. Rates would be higher than those paid by other state residents not living in areas with salinity impairment.

Potential cost savings to community residents which could be acquired through the sale of treated water, funding programs to assist in the construction costs, and avoidance of additional treatment costs for other pollutants (*i.e.* future TMDL requirements) are not included.

TABLE 15. RANKING OF SEWAGE RATES FOR MAJOR CITIES (STATE WATER RESOURCES CONTROL BOARD WASTEWATER USER CHARGE SURVEY REPORT MAY 2001)

Location	Rate per Month per Household	Notes
California Low	$ 4.25	
City of Santa Clarita	$10.96	Existing rate
Santa Clarita with Source Reduction	**$12.71**	
Los Angeles County Average	$15.01	
California Average	$19.82	
Ventura County Average	$23.15	
San Diego County Average	$26.24	
Santa Clarita with reverse osmosis and brine line (RWQCB 120 M+5 M O&M)	**$29.57**	2001 demand
Average of all California County Highs	$39.86	
Santa Clarita with reverse osmosis and brine line (CSDLA 244 M+4.3 M O&M)	$44	2001 demand

San Luis Obispo County High	$55	
Ventura County High	$73.75	
San Diego County High	$75	
California High/Los Angeles County High	$145.50	

APPENDICES

1. WATER QUALITY AND AGRICULTURAL SUPPLY - REFERENCE MATERIAL
2. ADDITIONAL BACKGROUND - STATISTICAL ANALYSIS
3. ALTERNATIVE MARGIN OF SAFETY ANALYSIS
4. ADDITIONAL BACKGROUND - CHLORIDE SOURCE REDUCTION
5. BENEFICIAL USES FOR SANTA CLARA RIVER
6. CEQA
7. REFERENCES

Appendix 1

WATER QUALITY AND AGRICULTURAL SUPPLY - REFERENCE MATERIAL

This appendix provides background information regarding water quality requirements for chloride necessary to support agricultural supply beneficial uses. The appendix contains information from several sources, including:

1. Regional Board Staff Report supporting Resolution 00-20.
2. Regional Board Staff Report supporting the Calleguas Creek *Basin Plan* Amendment, December 10, 2001

Regional Board Staff Report supporting Resolution 00-20.

When the "Drought Policy" was adopted in 1990, growers in Ventura County commented that the interim limits of 190 mg/L did not protect salt sensitive crops. At the adoption of the "Chloride policy" in 1997 the Regional Board directed staff to assess the agricultural water supply requirements before bringing forward a chloride resolution for these areas.

- Crop Location

Avocado and strawberries have been grown throughout the lower Santa Clara River watershed since 1975, but are not currently grown in the upper parts of the watershed. Staff made a visual inventory of crop locations in the summer of 1999. Between the mouth of the river and Highway 101, row crops, such as strawberries, predominate, and no orchard crops were observed. Between Highway 101 and Saticoy, row crops diminish in prominence and avocado and citrus orchards are seen. Between Saticoy and Fillmore, avocado and citrus orchards are very common, extending from the river to the foothills. Between Fillmore and Piru, avocados become less common and citrus orchards predominate. Between Piru and the County Line, the citrus orchards are less common, and are replaced by row crops at about the L. A./Ventura county line.

The general crop locations described above were confirmed by local agricultural experts, Dr. Ben Faber of UC Cooperative Extension, and Darrel Nelson of Fruit Growers Laboratory. Dr. Faber estimated that 6,000 acres are planted in avocado and 21,000 acres are planted in citrus.

Southern California Association of Governments (SCAG) 1993 land use coverage confirms that agricultural usage is extensive between Highway 101 and the L. A./Ventura county line. The general crop locations were confirmed on several maps. Ventura County Water Resources Division created a land use map based on a benefit assessment study and tax assessor records. The Los Angeles County Sanitation District created a map on land use that shows agricultural usage from an unspecified source. The Ventura County Farm Bureau also maintains records showing crop location and agricultural use.

- Source of Agricultural Supply Water

Avocado and strawberries are some of the crops irrigated by groundwater pumping and diversion from the Santa Clara River. Surface water rights records show the largest current agricultural allocation of the Camulos Ranch, Santa Clara River water are for Santa Clara Water and Irrigation District, Newhall Land and Farming and United Water Conservation District.

Santa Clara Water and Irrigation District and Newhall Land and Farming Company report that they do not provide surface water for crop irrigation purposes. United Water Conservation District reports regular surface water diversion for irrigation purposes at the Freeman Diversion structure. Smaller surface water diversion structures are known to exist, including one reported near the L. A. /Ventura county line for irrigation on Camulos Ranch which grows avocado and row crops.

Irrigation from groundwater is a more common practice. Irrigation production wells have been identified throughout the watershed. Pumping results compiled by United Water Conservation District show over 55,000 acre-feet of water were pumped from the Piru and

Fillmore basins during 1996 for agricultural purposes. Pumping for both basins was higher during the dry period from 1984 to 1991 than in the wet period from 1992 to 1996 (Piru and Fillmore Basins, United Water, 1997)

- Agricultural Reduction of Chloride Loading

Based on staff observations and discussions with growers, we understand that droughts and increasing water costs have led the majority of farmers in both Santa Clara and Calleguas watersheds to practice water-conserving irrigation practices. Most have already installed non-foliar irrigation systems for avocado and strawberry. Because irrigation water is the largest single source of chloride applied to crops, these water saving practices also reduce chloride loading. In addition, the practice of leaching salts, particularly chloride, out of the soil is widespread and accepted in the agricultural community. When leaching is required and concentration in available water is high, a second water source may be required. In Santa Clara groundwater provides an affordable second water source and in Calleguas, municipal water purveyors provide an alternative water supply. For these reasons, we propose protecting irrigation water for avocado and strawberry crops at levels that assume farmers use leaching, have non-foliar irrigation, and have access to an affordable second water supply.

- Crop Sensitivity

Bar and others looked at chloride and nitrate effects on avocado and citrus seedlings in a sandy soil. Minor leafburn was observed on avocado leaves (scale 0-no scorching to 5-severe scorching) at levels of 0.5 and 1 with 2mM (70 ppm) chloride. This rose to 1.25 to 1.75 scorching levels with 4mM (136 ppm) chloride. Branch growth and leaf damage were also reported in citrus plants at higher levels.

Dr. Gary Bender applied reclaimed water to mature avocado trees using reclaimed water in Escondido, California. The study showed loss of production where the applied water exceeded 180 mg/L, but did not compare production in waters with less than this concentration. However, the study describes waters between 110 and 180 as potable and those used as the base case in the study ranged from 36 to 196 mg/L with an average of 71 mg/L. According to the author "the literature has reported that the maximum amount of chloride in water tolerated by avocado without development of leaf injury is 107 mg/L" (pg. 6-3). Higher levels than the water quality base case averaging 71 mg/L showed decreased production in lbs/acre of 29% or greater. The onset of leaf injury found in this study is interpreted to occur between 71 and 180 mg/L.

Ben Faber, UC Cooperative Extension Farm advisor in Ventura and Santa Barbara Counties summarized crop sensitivity to chloride in his 1999 article in California Growers Magazine. "100 ppm of sodium or chloride can present problems for tree growers. The problems typically show themselves as tip-burn and defoliation……It doesn't mean that the water is impossible to use, only that greater attention needs to be made to ensure that these salts are adequately leached." (pg. 8)

Dr. C.D. Gustafson reported completing a "study of chloride damage in San Diego County orchards and found that tip-burn on leaves was prevalent in late summer if the chloride concentration of the irrigation water is higher than roughly 100 ppm or about 3 meq/l." (pg. 59)

The 1996 Region 9 (San Diego) *Basin Plan* lists chloride in the Table 3-1 Guidelines for interpretation of water quality for irrigation. Specified ion toxicity which affects sensitive crops for chloride applied by surface irrigation which concentrations below 140 mg/L has no restriction on use, whereas use is restricted above 140 mg/L. For sprinkler irrigation, water with 100-140 mg/L has no restrictions, and water with concentrations above 140 mg/L does have restrictions. Their footnotes on this table are as follows 1)Most tree crops and woody ornamentals are sensitive to sodium and chloride, use the values shown and 2)with overhead sprinkler irrigation and low

While sources agree avocado and strawberry crops are sensitive to chloride, there are no values above which all reporters concur that yield is diminished or that horticulture is not economically feasible. The lowest reported observable adverse effect level (first sign of damage) reported in a laboratory study was 70 mg/L, and in a field study, 71 mg/L. Other field studies, laboratory studies, expert opinion and farm advisory guidelines describe adverse effects to avocado and strawberry beginning with 100-107 mg/L chloride concentration in irrigation water. Minimum Regional Board agricultural guidance values for chloride vary from 70 or 100 mg/L to 140 or 143 mg/L, sometimes with non-foliar (mini sprinkler or drip) restrictions on use. Historical levels in irrigation water in the Santa Clara River, where these crops are grown successfully, have averaged from 40 to 143 mg/L.

Growers and agricultural experts report that in the nearby Calleguas watershed, avocado has been grown with diminishing success at concentrations between 120 and 150 mg/L. Avocado production became unfeasible, and many growers abandoned avocado production, when concentrations rose to between 150 and 180 mg/L. Maximum Regional Board agricultural guidance values for chloride vary from 150 mg/L to 350 mg/L. Twenty years of historical chloride data in the Santa Clara River show that concentrations exceeded 180 mg/L only in the immediate vicinity of the POTW discharge at Santa Paula, and only on rare occasions. Furthermore, the maximum at a 95% confidence level in the vicinity of Santa Clarita is 180 mg/L.

Based on this information, we conclude that with non-foliar irrigation and leaching, avocado can be grown at concentrations between 100 and 120 mg/L. At levels between 120 mg/L and 150 mg/L other sources of water must be available at lower concentrations for leaching. Short-term increases in chloride contributions between 150 and 180 mg/L lead to diminished yield which can be tolerated only under optimal conditions, and with alternative water supply or winter rains for leaching. The selection of a maximum, not-to–exceed value, of 180 mg/L was partially based on documented production loss with this level in irrigation water quality.

Staff is proposing an option for measuring compliance with these objectives as a rolling annual average concentration of 100 mg/L in surface water at Santa Paula where almost all water diverted from the river is for agricultural use. This level meets agricultural requirements as specifically reported by strawberry growers using this water.

Staff is also proposing an option to measuring compliance with a rolling annual average concentration in surface water of 143 mg/L in the Santa Clarita area where surface diversions are not used for irrigation. Because the surface water immediately mixes with groundwater, which is used for agricultural supply quality, the impact of future loading was estimated. The predicted future levels should satisfy agricultural requirements through 2010

- The conclusions from these analyses are that chloride sensitive crops have been grown since 1975 in the Santa Clara watershed. These crops are avocado and strawberry. Although the first damage to avocado crops is documented at 70 – 71 mg/L, they are grown with diminishing success between 100 mg/L and 180 mg/L. The damaging effects of higher concentrations can be mitigated if a secondary source of supply is available for leaching, and non-foliar irrigation are practiced. In the Santa Clara watershed, groundwater currently provides a secondary agricultural supply in the vicinity of the Santa Clarita, so a slightly higher concentration of 143 mg/L is considered sufficiently protective. At Santa Paula where direct diversion is practiced and river water is the primary irrigation source, a lower concentration of 100 mg/L is recommended.

Regional Board Staff Report supporting the Calleguas Creek *Basin Plan* Amendment, December 10, 2001

The agricultural beneficial use (AGR) is defined by the *Basin Plan* (CRWQCB, 1994) as "uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing." The beneficial use guidelines specify that "protection of the most sensitive beneficial use(s) would be the determining criteria for the selection of effluent limits." The beneficial uses most sensitive to chloride in the Calleguas Creek watershed are agriculture and groundwater recharge, where the groundwater is used to irrigate salt-sensitive crops. WQOs are selected based on allowable concentrations that will protect those beneficial uses that existed on or after November 28, 1975, or were potential or intermittent.

- The 1994 *Basin Plan* specifies guidance values for chloride levels necessary to support agricultural beneficial uses as ranging from 100 to 355 mg/L. This guidance also allows considerable leeway in selecting WQOs, and considerable flexibility in selecting the WQO protective of actual uses and observed impacts in each reach of the waterbody.
- Local avocado farmers from the Calleguas Creek watershed and the Santa Clara River watershed have testified that continued irrigation with water exceeding 120 mg/L in the Calleguas and Santa Clara River watersheds has an adverse impact on avocado production (Regional Board meeting, December 7, 2000, transcript and various correspondences). These findings are consistent with staff's independent literature review.

The lowest reported observable adverse effect level (first sign of damage) reported in a laboratory study was 70 mg/L, and in a field study, 71mg/L. Other field studies, laboratory studies, expert opinion and farm advisory guidelines describe adverse effects to avocado and strawberry crops beginning with 100-107 mg/L chloride concentration in irrigation water. Bar and others looked at chloride and nitrate effects on avocado and citrus seedlings in a sandy soil. Minor leaf burn was observed on avocado leaves (scale 0-no scorching to 5-severe scorching) at levels of 0.5 and 1 with 2mM (70 ppm) chloride. Branch growth and leaf damage were also reported in citrus plants at higher levels.

Dr. Gary Bender applied reclaimed water to mature avocado trees in Escondido, California. The study showed loss of production where the applied water exceeded 180 mg/L, but did not compare production in waters with less than this concentration. However, the study describes water between 110 and 180 mg/L as potable and those used as the base case in the study ranged from 36 to 196 mg/L with an average of 71 mg/L. According to the author "the literature has reported that the maximum amount of chloride in water tolerated by avocado without development of leaf injury is 107 mg/L (pg. 6-3). Higher levels than the water quality base case averaging 71 mg/L showed increased production in lbs/acre of 29% or greater. The onset of leaf injury found in this study is interpreted to occur between 71 and 180 mg/L. (Bender, 1996)

Ben Faber, UC Cooperative Extension Farm advisor in Ventura and Santa Barbara Counties summarized crop sensitivity to chloride in his 1999 article in California Growers Magazine. "100 ppm of sodium or chloride…can present problems for tree growers. The problems typically show themselves as tip-burn and defoliation….It doesn't mean that the water is impossible to use, only that greater attention needs to be made to ensure that these salts are adequately leached." (Faber, 1998)

Downton and others looked at growth and flowering of avocado trees. Seedlings were grown in loam and watered with concentrated irrigation water. Regular leaching removed salt buildup. No impacts were seen at concentrations of 0 mg/L. With an increase in chloride concentration to 170 mg/L, the researchers documented reduced trunk diameter, reduced dry weight, and increased flowering. (Downton, 1978)

In summary, a review of literature and other expert opinion indicates that optimal conditions for avocado production within Ventura County are created by irrigation with water containing less than 120 mg/L; concentrations exceeding 120 mg/L have resulted in reduced yield. Although crops can tolerate some fluctuation in the chloride concentration, avocado production was not considered viable with irrigation water exceeding 180 mg/L.

The intention of the 1975 *Basin Plan* to provide this flexibility in the establishment of mineral objectives for agricultural supply is made clear in the reference for the chloride guidance values. The document describes the criteria for agricultural supply water:

> "Absolute limits to the permissible concentrations of salts in irrigation water cannot be fixed, for several reasons: A) It is almost universally true that the soil solution is at least three to eight times as concentrated as the water that replenished it, because of evaporation of water from the soil surface, transpiration of plants, and the selective absorption of salts by plants. B) There is apparently no definite relationship between the concentration and composition of the irrigation water and those of the soil solution, which in some cases may be as much as 100 times more concentrated than the water. C) Plants vary widely in their tolerance to salinity, as well as of specific salt constituents. D) Soil types, climatic conditions (such as temperature, rainfall and humidity) and irrigation practices may all influence the reaction of the crop to the salt constituents. E)

> Interrelationships between and among constituents may be highly significant. (McKee and Wolf, 1963, page 107).

The proposed WQO of 110 mg/L based on a 12-month rolling average, and a maximum not-to-exceed of 180 mg/L is believed to be protective of avocado crops under local growing conditions, while providing flexibility by allowing for fluctuation in short-term chloride concentrations.

Appendix 2

ADDITIONAL BACKGROUND - STATISTICAL LINKAGE ANALYSIS

A statistical analysis was used to predict the effect of the TMDL remedies. A dynamic surface and groundwater model for the interpretation of water quality does not exist for the Upper Santa Clara River, although a static model was completed by CH2MHill for Newhall Land and Farming in 2001 and one was completed for the lower watershed by the United States Geological Survey and United Water Conservation District in 1998. The Department of Water Resources completed an extensive study of the upper watershed in 1993, at the request of the Regional Board, and identified some water quality trends. The statistical methodology employed in that work was considered the best available method to assess the data available for consideration in this TMDL.

Previous work had identified seasonal variations and groundwater contributions as poorly quantified effects that caused greater variations in the data than other phenomenon, such as anthropogenic effects. In addition to the Regional Board staff work beginning in 1974, other previous works include Slade's 1983 study of safe-yield and Kennedy/Jenk's 1998 mass balance. All these studies, and the DWR report, concur that the flow of the Santa Clara River is bimodal, with brief floods followed by declining flows and extended periods of low flows. They agree that river water percolates to groundwater and is recharged by it. Finally, these works also concur that the head waters of the watershed have lower chloride concentrations that the water that leaves the Upper reaches of the Santa Clara River at Blue Cut Gauging stations. The conclusions of previous work was used to limit the data evaluated for this TMDL to that collected in a single season and collected at a location in the reach with the least variation in the groundwater influence.

Of the multiple variables which could be evaluated statistically, those studied were selected using a simple model of the ground and surface water interactions in the vicinity of Highway 99 and Blue Cut (See Figure 7). The variables chosen for study had to be represented by a large number of measures. For example, the surface flow at Highway 99 and Blue Cut are comprised of WRP effluent, surface flow and rising groundwater flow and have been measured consistently after 1971. Similarly, the flow and concentrations of the effluent and the surface flow are well characterized at the end-of-pipe or in-river. In contrast, the rising groundwater flow that is poorly quantified.

Among the variables identified in the hydrological model, those for WRP effluent, and Blue Cut and Highway 99 in-river flow and concentration were chosen for further analysis. The variations in groundwater discharge and percolation were minimized by using in-river measurements at the end of each reach in-lieu of the average of all measures in the reach.

While the in-river conditions at Blue Cut and Highway 99 are not equivalent to those measured in the entire reach, they represent the most homogeneous and predictable hydrological conditions. The shallow impermeable beds at Blue Cut and fault groundwater barriers at Highway 99 provide two unique locations where subsurface flow is limited. Variations in surface water quality associated with changes in the rates of groundwater percolation and discharge are minimized. As a result, hydrological variables at the bottom of each reach are expected to be more reliable indicators of both ground and surface water quality conditions within the reach.

Seasonal variations were limited in the study by examining chloride in impaired reaches only during the driest six months of the year where possible.

The following statistical tests were performed on concentration and load (derived from flow and concentration) values. First the presence of a normal or log-normal distribution for the variable was tested. Then the presence of a correlation with another variable was sought. Where a normal or log-normal distribution was found, the degree of the correlation was used to assess the value of the measure. Finally, the measure must represent an actual physical variable that is expected to act independently and that measure must be useful in assessing the results of the TMDL.

For example, the correlation between flow and concentration measured in WRP discharge was among the best measured (see Figure E2). However, flow and concentration are not expected to have an actual physical correlation for treatment plant effluent. The correlation may exist because imported water concentrations have fallen during the last decade while plant size has increased. Finally, the correlation of WRP concentration to the concentration at Blue Cut was poor (see Figure E3). This limited their utility in predicting the effects of the TMDL remedies.

Alternately, the difference in the concentration between the WRP effluent and a seasonally-limited data set from Blue Cut, showed good evidence of a log-normal distribution (see Figure E4). In addition, the difference measured at Blue Cut showed a good correlation with the WRP effluent (see Figure E5 and E6). The better correlation between the difference and the effluent is attributed to (1) a calculation effect in that the variations in the WRP effluent concentration are removed from the measures at Blue Cut, and (2) a physical effect in that effluent enters the groundwater, mixes in the aquifer, and is discharged again downstream so that the difference measures the ability of the natural system to dilute different effluent concentrations. The simpler and poorer correlation between Blue Cut concentration and WRP effluent was not used because a reasonable physical explanation exists for the improvement of the correlation coefficient of the difference with the effluent. Finally, the difference has great utility in predicting the success of changes in WRP effluent concentration.

The results are as follows:

A. Valencia and Saugus WRP concentrations and flows are independent variables relative to the natural system.

B. The Valencia WRP monthly average effluent chloride concentration minus the Blue Cut concentration for May through October between 1971 and 2000 was found to be log-normally distributed (see Figure E4).

C. The Saugus WRP monthly average effluent chloride concentration minus the Highway 99 concentration for Highway 99 values less than 120 mg/L from1971 to 2000 was found to be log-normally distributed (see Figure E9 and data set in Table E11).

D. The difference described in B. was found to correlate with the Valencia WRP monthly average effluent chloride concentration (see Figure E16).

E. The difference described in C. was found to have a limited correlation with the Saugus WRP monthly average effluent chloride concentration (see Figure E8).

F. The Saugus WRP monthly average effluent chloride concentration minus the Highway 99 concentration for Highway 99 values greater than 120 mg/L from 1971 to 2000 was found to be normally distributed.

G. The difference described in F. was not found to have any correlation with the Saugus WRP monthly average effluent chloride concentration.

H. The Blue Cut chloride concentration was not found to have any correlation with the Highway 99 chloride concentration.

I. The Blue Cut chloride load was not found to have a correlation with the Valencia WRP load.

The difference between the combined flow at Blue Cut or Highway 99 and the upstream WRP effluent and the characteristics of that effluent were each identified as independent variables. Other hydrologic parameters were not found to be related in a statistically valid manner or did not characterize effects that were useful in predicting the result of TMDL remedies.

Specifically, the differences between the Valencia WRP average monthly effluent concentrations and the instantaneous Blue Cut concentration measures are log-normally distributed[1] (P is .44 and A is .36[2]). In addition, the differences between the Saugus WRP average monthly effluent concentrations and the instantaneous Highway 99 concentration measures are log-normally distributed[3] (P is .41 and A is .38[4]). Further, the differences show some correlation (R^2 is .50 and .27, respectively[5]) with the effluent concentration.

For the vicinity of Blue Cut (Reach 5), 93 differences were calculated between the monthly average effluent discharge concentration from the Valencia WRP and water quality samples measured in the vicinity of Blue Cut between 1971 and 2000 after April and before November. The differences were log-normally distributed. The average difference measured was 40 mg/L for all effluent concentrations indicating that the natural system provided this level of dilution to the effluent. The value is consistent with an average effluent discharge of 143 mg/L on those dates and an average concentration at Blue Cut just above 100 mg/L.

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[1] A log-normal distribution is characteristic of natural water quality data. All of the available data from May through October showed this distribution with the removal of four data points; an unusually low in-stream Blue Cut concentration value of 54mg/L measured in July 1990, one unusually high in-river Blue Cut concentration value of 182 mg/L measured in January of 1985, one unusually high concentration measure of the Valencia effluent of 341 mg/L in November of 1980 and two Blue Cut in-river concentration values, which were taken on the adjacent dates of April 17 and April 25 in 1972, but which show a rapid change from 95 to 78 mg/L, respectively. These values are inconsistent with all other data and are attributed to measurement of an additional water source, such as an irrigation overflow event or conservation flow from Castaic Lake.

[2] Anderson -Darling Normality test says when P> A, the test is positive for the hypothesis that the variables are normally distributed. The logarithm of the Valencia-Blue Cut difference was normally distributed and the logarithm of the Saugus-Highway 99 difference was normally distributed.

[3] A log-normal distribution was observed for the differences where the Highway 99 concentrations below 120 mg/L (N=149 or 4.5 data points per year of sample). All the Highway 99 data below 120 mg/L showed this distribution with the removal of three data points; very low effluent discharge concentration values at Saugus in July and November of 1980 and January of 1981 during periods of low in-river concentrations at Highway 99. These values are inconsistent with all other data and are attributed to measurement of an additional water source, such as an irrigation overflow event or flows from Bouquet Reservoir. A log-normal distribution characterizes the differences where Highway 99 is greater than 120 mg/L (N = 50). The entire water quality record at Highway 99 appears to be comprised of two data sets (Figure E14), one with Highway 99 values above 120 mg/L and one with Highway 99 values below 120 mg/L. The higher concentrations were almost all measured before 1985 (Figure E15)and are attributed to brine discharge associated with oil exploration in Placerita Canyon on the South Fork of the Santa Clara River. These discharges were controlled by permit beginning in 1975. The data that are less than 120 mg/L are believed to represent other natural sources.

[4] Anderson -Darling Normality test says when P> A the test is positive for the hypothesis that the variables are normally distributed. The logarithm of the Valencia-Blue Cut difference was log-normally distributed and the logarithm of the Saugus-Highway 99 difference below 120 mg/L was log-normally distributed.

[5] R^2 is a measure of how well the differences and the corresponding effluent concentrations compare to a linear equation. An R^2 of 1 would indicate a perfect correlation, and an R^2 of 0 would indicate no correlation between the values and a line. The .50 R^2 for Valencia is for summer differences measured after 1971.

For the vicinity of Highway 99 (Reach 6), 149 differences were calculated for measures between 1971 and 2000 below 120 mg/L. The values were log-normally distributed relative to the monthly average effluent concentration at the Saugus WRP. The average difference was 41.5 mg/L. That is consistent with an average effluent discharge of 143 mg/L and a long-term average concentration at Highway 99 that is about 100 mg/L.

The uniform distribution of the difference between the in-river concentrations and the upstream WRP effluent and the relationship of that difference to the effluent concentration, which would be modified by the methods of the TMDL, make these parameters ideal candidates for a statistical assessment predicting the results of the TMDL.

These statistical relationships suggest that the dilution provided by the natural system to the WRP effluent is more predictable than variations in that effluent combined with the variations in the dilution provided by the natural system. The statistical correlation is sufficient to predict the in-river concentration resulting from a given WRP concentration during the driest six months of the year during all critical conditions represented in the historical record with the frequency they appear in that record.

APPENDIX 3

ALTERNATIVE MARGIN OF SAFETY ANALYSIS

This appendix discusses alternatives for applying an explicit margin of safety (MOS) to the Upper Santa Clara River Nutrient TMDL. Three methods of applying an explicit MOS to the numeric target were considered by Regional Board staff. In addition to the recommended alternative wherein an explicit MOS was not applied, the alternatives evaluated by Regional Board staff include: (1) applying an explicit 10% MOS to the WRP effluent limits with the objective of achieving the WQO at the bottom of each reach, (2) modifying the water quality objective to measure compliance as an annual rolling average rather than an instantaneous measurement, and (3) applying a 10% MOS to the water quality objective. <u>It is noted that the current WQO for Reaches 5 and 6 is 100 mg/L chloride and a target greater than the existing WQO may require either a WQO change or a site specific objective to preclude future findings of impairment.</u> These alternatives were analyzed by Regional Board staff based on comments received at public outreach meetings. Because this TMDL includes development of a site-specific objective, if appropriate, the following alternatives can be considered for use in conjunction with the SSO.

Clean Water Act Section 303(d) requires a Margin of Safety (MOS) to account for uncertainties in the TMDL analysis. The required MOS may be provided explicitly by reserving (not allocating) a portion of available pollutant loading capacity and/or implicitly by making conservative analytical assumptions in the supporting analysis. This TMDL provides both an explicit and implicit MOS.

This TMDL is based on proposed that (1) a 10% MOS is added to the numeric targets proposed in this TMDL, resulting in an average in-river water quality of 100 mg/L in Reaches 5 and 6 and waste discharge limits of 104 mg/L at the Valencia WRP and 103 mg/L at the Saugus WRP. The other alternatives are (2) add a 10% MOS to the existing 100 mg/L Water Quality Objective measured instantaneously when dilution is absent, or (3) recalculate the numeric target for an objective measured as a rolling annual average and add the 10% MOS. The second alternative results in lower waste discharge limits of 90 mg/L. The third alternative results in higher in-river chloride concentrations and waste discharge limits of 113 mg/L for Valencia WRP and 112 mg/L for Saugus WRP, respectively. The first and third alternatives require revision of the water quality objective or a site-specific objective. These discharge limits are estimated based on available data which staff considers insufficient to support the recommendation of a site-specific objective. Further studies would be required during the Implementation Plan to provide supporting evidence ensuring the protection of all beneficial uses before the first or third alternatives could be applied. Table 1-A3 summarizes the results of the alternative methods of applying the MOS.

TABLE 1-A3. CALCULATION OF DISCHARGE LIMIT (WLA) WITH EXPLICIT MARGIN OF SAFETY

Water Quality Objectives mg/L	Numeric Target mg/L	Data used for Calculation of Numeric Target	Explicit MOS	Final Discharge Limit (WLA) mg/L
104, 103 SSO[1]	Valencia 116 Saugus 114	Entire Historical Record	10% reduction in concentration	<u>Proposed:</u> Valencia 104 Saugus 103
100 existing	Valencia 100 Saugus 100	Extreme Drought Conditions	10% reduction in concentration	90
113,112 SSO	Valencia 126[2] Saugus 127	Data Sufficient to Estimate Rolling Annual Average	10% reduction in concentration	Valencia 113 Saugus 112

For alternative one, the waste discharge limit is calculated from the numeric target identified from this historical record described above and results in attainment of the objective in 90 % of the samples measured. An explicit 10% MOS is added to the 116 mg/L Valencia and 114 mg/L Saugus numeric targets to result in discharge limits just over the objective, at 104 mg/L and 103 mg/L, respectively.

For alternative two, the waste discharge limit could be calculated directly from the water quality objective assuming only the most critical condition, that is, the absence of diluting flows. In this interpretation, the numeric target and the discharges at the end of the pipe could not

[1] Site specific objective – allows Regional Board to set specific objectives based on site conditions
[2] Actual values may vary based on additional site specific objective analysis.

exceed 100 mg/L, the same as the Water Quality Objective. The addition of an explicit 10% MOS results in waste discharge limits of 90 mg/L.

In alternative three, the MOS is expressed by changing the method of concentration measurement. For example, an instantaneous measure is a more conservative measure of concentration than a daily or annual average. Conversely, a longer period of averaging allows for a greater margin of error in the prediction of daily conditions.

In the third alternative, it is estimated that a modified objective of 100 mg/L measured as a rolling annual average would introduce the necessary MOS to the proposed numeric target, by including a margin for error in the prediction of daily conditions. The numeric target at Valencia and Saugus WRP, measured as a rolling annual average, is estimated to be 126 and 127 mg/L, respectively. The addition of a 10% explicit MOS produces waste discharge limits of 113 and 112 mg/L, respectively. The full analysis is discussed in the appendices.

If the Regional Board adopts a waste discharge limit which requires the promulgation of a site specific objective during the Implementation Plan and the existing Water Quality Objective is not modified, then the requirements of the TMDL can be met by imposing the most restrictive waste discharge limit. This limit of 90 mg/L assures attainment of the existing water quality objective under the most critical condition.

This TMDL also provides an implicit MOS by including conservative assumptions in the supporting analysis. Table 2-A3 describes these sources of uncertainty and the conservative assumptions and approaches used to account for them in the TMDL analysis.

TABLE 2-A3. SOURCES OF UNCERTAINTY AND IMPLICIT MOS PROVISIONS

Source of Uncertainty	Implicit MOS Provisions
Chloride concentrations show great seasonal and annual variations.	Long record of historical data used to calculate numeric target averages out annual variations. Further, only the critical summer season is evaluated where possible, eliminating the effects of some seasonal influences
Available data are limited in quantity and quality.	All available data were used for the TMDL.
Water softeners, growth may add load.	Increased loading to the waste dischargers could result from an increase in the urban population, or a greater market penetration of self-regenerating water softeners. The cost associated with the remedy necessary for the higher chloride concentrations may increase as a result of these factors, but they do not change the assimilative capacity of the river nor the recommended discharge requirements. The TMDL incorporates the most negative impacts of growth through 2015 based on the plans available.
Water Rights and Groundwater Pumping: Several surface water rights decisions for Santa Clarita area are pending.	TMDL assumes existing utilization of the groundwater flows present, which is equivalent to the safe yield estimated by numerous workers[1]. This suggests that higher groundwater extraction rates cannot be sustained. Continuing and future monitoring and re-examination of the success of the TMDL may provide some protection against increased extraction volumes.

MOS Assuming a Site-Specific Objective of 100 mg/l Measured as a Rolling Annual Average

The longest continuous period of monthly records at Blue Cut were measured in 1999-2000, when impairment was recorded, and in 1992, at the end of a long-term drought. If the historically measured differences between Blue Cut and the Valencia WRP effluent for these periods are applied to various concentrations of the WRP effluent and the result measured as a rolling annual average, it is seen that an effluent concentration of 126 mg/L results in Blue Cut measures less than 100 mg/L in 90% of the cases studied. Analysis of the entire historic record resulted in the proposed numeric target for Valencia is 113 mg/L, so 13 mg/L of additional concentration is assumed for dilution by winter flows when a rolling annual average is measured. If this same change is applied to the proposed numeric target for Saugus of 106 mg/L, the concentration that would achieve 100 mg/L as a rolling annual average is 119 mg/L. Table 3-A3 shows the alternative calculation of discharge limit with explicit margin of safety

[1] Slade, 1983 and Santa Clarita Valley Water Report 1998 describe average safe yield for the alluvial aquifer as 32,500 acre-foot/year, a value exceeded in pumping after 1993 by water purveyors in the upper Santa Clara Valley as reported in 1998

TABLE 3-A3. ALTERNATIVE CALCULATION OF DISCHARGE LIMIT (WDR) WITH EXPLICIT MARGIN OF SAFETY

Water Quality Objectives	Numeric Target mg/L	Analysis Tool	Explicit MOS	Final Discharge Limit (WLA) mg/L
100 mg/L in drought	Valencia 100 Saugus 100	Assumption of no dilution in drought	10% reduction in concentration	90
100 mg/L existing instantaneous measure of concentration	Valencia 116 Saugus 114 derived from 90% of historical measures	Statistical analysis of historical measures at Blue Cut and Highway 99	10% reduction in concentration	Proposed: Valencia 104, Saugus 103
100 mg/L site specific objective for reaches between Blue Cut and Bouquet Canyon promulgated during implementation based on additional technical analyses within 2 years after adoption	Valencia 126[1] Saugus 127 derived from 90% of measures during periods when rolling annual average could be calculated	As above with prediction of rolling annual average based on 1999 and 1992 Blue Cut data	Measure WQA as rolling annual average and apply 10% reduction in concentration	Valencia 113, Saugus 112

[1] This staff estimate is not considered sufficiently precise for a site-specific objective change. Actual values may vary based on additional stakeholder site specific objective analysis.

APPENDIX 4

ADDITIONAL BACKGROUND - CHLORIDE SOURCE REDUCTION

This appendix provides additional background information regarding chloride source reduction methods. The TMDL analysis shows that WRP discharge is the largest contributor to the chloride in the watershed. Possible options for reducing the WRP contribution are alternative disinfection methods, reducing the urban waste load, and reducing the load in the source water. The impact of reduction in the urban waste load and source water are described in Table 1-A4 and Table 2-A4.

TABLE 1-A4. NON-DROUGHT SOURCE REDUCTION REMEDIES AND THE CALCULATED EFFECT ON THE EFFLUENT CONCENTRATION

Source Reduction Remedy	Process	Reduction in mg/L	Effluent concentration
No Source reduction			130 mg/L [1]
Elimination of chlorine disinfection of waste	Ultraviolet or ozone treatment	5-15 mg/L	115mg/L[2]
Elimination of chlorine disinfection of pumped water	Ultraviolet or ozone treatment	DHS may prohibit	
Prohibitions on chlorine soaps and products	Education on alternative products[3]	5-10 mg/L	105mg/L[4]
Voluntary replacement of self-regenerating water softeners with canisters	Education, rate adjustments and/or rebates for existing water softener users	25 mg/L[5]	80mg/L[6]
Reduced salt load in imported water	Legislative, public and water agency efforts underway	Impact unknown[7]	Unknown
Non-Drought Effluent			80 mg/L

[1]Reductions are from an average urban loading concentration of 85 mg/L (Resolution 02-97) plus the loading of the average non-drought imported source water contribution of 45 mg/L (Jensen Treatment Plant, MWD 1975-1996) for an initial concentration of 130 mg/L.

[2] 85mg/L+45 mg/L -15mg/L= 115mg/L

[3] A typical range on chloride additions from products during domestic use is 20 to 100 mg/L[3]. Although the average value is 50 mg/L, a further reduction of 5-10 mg/L may be attained through education on product choice or prohibition.

[4] 115 mg/L-10mg/L=105mg/L

[5] The owner of a self-regenerating water softener refills the device with salt, containing 60% chloride ions, which the machine uses to automatically recharge the softening medium. When the recharge process is completed, a brine with high concentrations of chloride is discharged to the sewer, processed through the waste treatment plant, and discharged to the river. If the market penetration is estimated at 15% of the existing 67,000 connections, with each of these water softeners recharging a 100 pound salt reservoirs 4 times a year, according to the manufacturers recommendation for a popular model, the resulting load would be 6800 lbs/day. With the elimination of half of this population of water softeners through municipal programs such as rebates, education, or water or waste bill adjustments, the reduction in concentration would be 3400 lbs/day or about 25 mg/L of the current waste load.

[6] 105 mg/L-25mg/L=80mg/L

[7] Coordinated actions between Southern California water purveyors, the California legislature and the voters seeks to reduce salt intrusions into the Bay Delta and salt loading of the State Water Project. The objective of the Cal-Fed project and the Governor's Committee on Drought Preparedness is to maintain the existing water quality conditions which averages 45 mg/L under average conditions and 105 mg/L under drought conditions. Further reductions are possible but cannot be estimated.

TABLE 2-A4: DROUGHT PLUS NON-DROUGHT SOURCE REDUCTION REMEDIES

Drought Source Reduction Remedy	Process	Reduction in mg/L	Effluent concentration
No Source Reduction			140mg/L [1]
Voluntary drought shut-down of water softeners	Education, rate adjustments and/or rebates for water softeners	10 mg/L[2]	130mg/L[3]
Alternative water supply sources for use in drought	Replace 105 mg/L imported water with groundwaterat100 mg/L and aquifer storage recovery water at50 mg/L[4]	30 mg/L	80mg/L[5]
Reduction in imported water use	conservation and less irrigation[6]	7-20 mg/L	110 mg/L[1]
Final Drought Effluent			80 mg/L

Existing conservation programs (Alameda County Water District, 1995, MWD Regional Urban Drought Water Management Plan 1995, Urban Water Management Plan for the City of San Diego 1990, City of Los Angeles Urban Water Management Plan 1995) were used as models to design source reduction programs and estimate their costs and effectiveness. The relative cost and corresponding chloride reduction in lbs/day is tabulated below. Specifically, a water softener program which requires a surcharge for the use of the device, the banking of good

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[1] Assumes that source reduction remedies described in the preceding table are in place so the initial effluent concentration is 80 mg/L with an added 60 mg/L from imported water with the average non-drought concentration of 105 mg/L (Jensen Treatment Plant, MWD, 1975-1996) for an initial effluent concentration during drought conditions of 140 mg/L.

[2] Additional education, rate changes, or incentives during drought periods may persuade customers to turn off their self-regenerating water softeners for a limited period of time. A further 20% reduction in use would result in an additional temporary savings of about 1360 lbs/day or 10 mg/L.

[3] 80 mg/L +60 mg/L-10mg/L=130mg/L

[4] Proposal by Newhall Land and Farming, in response to questions about water supply of sufficient quality, to store imported water in aquifers and recover during drought (Newhall EIR 2001). Assumes final source water concentration is 75 mg/L.

[5] 110 mg/L-30 mg/L=80mg/L

[6] While municipal efforts to increase water conservation have led to reduced water use, reductions in waste load have not been documented. Reductions in the total chloride load that enters the river can be projected due to reduced irrigation and to less loading from imported water. However, actual concentrations of the effluent entering the plant may rise due to less dilution of soap, sewage and other urban loads and may require dilution with pumped groundwater, which has lower chloride levels, to achieve the numeric target. Reductions in imported water use due to education and conservation are estimated by the City of Alameda to be 9% and the City of Los Angeles to be 18% (1999 annual reports). If the savings are set at a value of 20% for the 2015 project flow of 71.5 cfs[6] at drought concentrations of 120 mg/L, then the reduced flow of 57.2 cfs would result in a saving of 20% of the load or a drop from 65 mg/L to 52 mg/L for a 13 mg/L savings. During temporary drought conditions, a further reduction in domestic use could be encouraged through a tiered rate structure, as opposed to the voluntary water conservation measures. Under drought conditions, the MWD reported a water use reduction of 29% without price controls. A 20% reduction thus seems a conservative estimate given cost incentives.

quality water in underground reservoirs, and the outreach programs for residents on irrigation practices showed the greatest returns on investment. A spreadsheet showing the details of the calculations is attached.

Source Reduction Programs	Water Softener Surcharge	GroundWater Banking	Residential Irrigation	Water Softener Rebate	Large Irrigation	Ozone Disinfection
Program Design	40% of 2015 users with audit + $10/mo surcharge	5 wells + 5 acft/yr+ infra-structure	50% drop in .2 acre irrigation per 2015 users	40% of 2015 users with $1000 rebate	50% of 6 golf course or park 3 acft/yr by 2015	2 existing plants
Annual cost$/lb per day chloride removed	-684	2	3	1582	5003	65462

Waste Dischargers have reported their inability to reduce water softener sources and identified this as the largest single source of chloride. The Regional Water Quality Control Board at San Luis Obispo (Region 3) reports a satisfactory resolution to the water softener issue when a Water Reclamation Plant offered to give rebates to customers who did not discharge brine into their sewers and completed inspections to ensure fair distribution of the rebates. The case indicates that additional options for the source control of chloride may exist beyond those represented here.

> <u>Case study of successful water softener source control:</u> A housing development around an existing golf course was proposed in Region 3 , with wastewater disposal to be via reclamation (irrigation of the turf). Specifications for the development prohibited on-site regenerated water softeners, but many homeowners either ignored or did not know about the restriction, and many self-regenerating units were installed. The County owns and operates the wastewater facility, which was in violation of salts limits within their WDRs, but could not prohibit water softeners outright. The incremental cost of treating wastewater to remove salts was found to be significant. The County then told home owners,

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[1] 130mg/L-20mg/L=110 mg/L

everyone would share in the burden to pay this incremental increase. However, anyone not having a brine discharge to the sewer would receive a credit on his or her sewer use bill equal the incremental increase of treating the brine waste. Not having a discharge means periodic inspection and certification by County personnel to verify either no water softener is present, or an off-site regenerated cartridge type softener is present. Water softeners now used in this development are the cartridge type, and are regenerated at a permitted facility where salts is not an issue. The public health code requires water softener regeneration brine to be discharged to the sanitary sewer, so no discharge of brines from self-regenerating units is allowed unless to the sewer (i.e. no discharges from residences allowed).

Source Reduction Strategies and Costs

(References for costs and additional description: Alameda County Water District 1995)

Source Reduction Programs	Water Softener Surcharge	Ground Water Banking	Residential Irrigation	Water Softener Rebate	Large Irrigation	Ozone Disinfection
annual cost, $/lb per day chloride removed	-683.55	1.8069	3.0134	1582.2	5002.5	65462

Water Softener Reductions Plans(replacement of self-regenerating water softeners with canister water softeners or removal)											
Rebate for self-regenerating water softeners						15% water	40% water	15% water	40% water	cost of program	
		Pop	Pop	Con-nections		softener	softener	Softener	softener	1 million/yr	
		(LACSD 1997)		Pop/3		Low	High	Low	High	(Alamda co pln)	
		2000	2015	2000	2015	2000	2000	2015	2015	2000	2015
Result or Calculation		185740	320933	61913	106978	9287	24765	16047	42791	1E+06	2E+07
cost of rebate				total cost of programs				total lbs/chloride per day			
$1000/ unit				per year			chloride=1/365(.6 times 100-400 lbs/salt-year)				
Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
2000	2000	2015	2015	2000	2000	2015	2015				
9E+06	2E+07	2E+07	4E+07	1E+07	3E+07	2E+06	4E+06	1526.6	16284	175.85	1875.8
Result Summary		low	1582.2	high	11770	$/lbs/day chloride					
Residential Audits and Surcharge for self-regenerating water softeners										cost of program	
		Pop	Pop	Connections		softener	softener	Softener	softener	1 million/yr	
		(LACSD 1997)		Pop/3		Low	High	Low	High	(Alamda co pln)	
		2000	2015	2000	2015	2000	2000	2015	2015	2000	2015
Result or Calculation		185740	320933	61913	106978	9287	24765	16047	42791	1E+06	2E+07
cost of audit and cost of surcharge				total cost of programs				total lbs/chloride per day			
$1000/audit minus $10/month-household surcharge were present				per year			chloride=1/365(.6 times 100-400 lbs/salt-year)				
Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
2000	2000	2015	2015	2000	2000	2015	2015				
8E+06	2E+07	-1E+07	-3E+07	9E+06	2E+07	144179	-1E+06	1526.6	16284	175.85	1875.8
Result Summary		low	-683.55	high	1399.7	$/ lbs/day chloride					

Alternative Disinfection						
Ozone	Valencia Discharge		Hill Cyn Ozone Plant @ 10 mgd	projected cost	two plants	chloride concentration reduction 10mg/L per 24.8 cfs
	19 mgd		1E+07	5E+06	1E+07	160.8
Result Summary	65462	$/lbs/day				

Irrigation Volume Reduction Plans (Reduction of irrigation volumes)										
Large Landscape Audits and Customized Rebate						cost of program				
	Number acres Large Landscapes			lbs/day @ 100mg/L		$100000 0/yr				
	3 5acre golf courses/cemetery @ 3 acft/yr-acre									
	2000	2015				2000	2015			
Result or Calculation	45	90		99.949	199.9	1E+06	2E+07			
Result Summary	low	5002.5	high	10005	$/lb/day chloride					
Residential and New Construction Water-Efficient Landscape Design Workshops										
	Pop	Pop	House-holds		irrigated land/		water@ 1 ac-ft/yr		reduction@ 10%	
	(LACSD 1997)		Pop/3		house=.2 acre				to .5 ac-ft/yr in acft/yr	
	2000	2015	2000	2015	2000	2015	ac-ft/yr		2000	2015
Result or Calculation	185740	320933	61913	106978	12383	21396	12383	21396	619.13	71.318
	cost of program									
chloride @ 100 mg/L	$100000 0/yr									
	2000	2015								
331855 38227	1E+06	2E+07								
Result Summary	low	3.0134	high	26.16	$/lb/day chloride					

Alternative Water Supply								
Groundwater Banking against drought					capital	operational	water cost	total cost/yr
	Alluvial Aquifer		Drought Imported	Savings	5 wells @	costs	$350/ac-ft	
	5 aft/yr @ 75mg/L		mg/L@105 mg/L	lbs/day	1 million	1 million		
	load		load					
Result or Calculation	1E+06		2E+06	582069	5E+06	1E+06	1750	1E+06
Results Summary		1.8069	l$/lbs/day					

Appendix 5

Santa Clara Beneficial Uses: Excerpt from *Basin Plan* Table 2

Excerpt from 1994 *Basin Plan* Table 2.1: Beneficial Uses for Santa Clara River Watershed											
Reach	Hydro. Unit No.	MUN	IND	PROC	AGR	GWR	FRSH	NAV	REC 1	REC 2	COMM
Santa Clara River Estuary	403.11							E	E	E	E
Santa Clara River	403.11								E	E	
Santa Clara River	403.21		E	E	E	E	E		Ed	E	
Santa Clara River	403.31		E	E	E	E	E		Ed	E	
Santa Clara River	403.41		E	E	E	E	E		E	E	
Santa Clara River	403.51		E	E	E	E	E		E	E	
Santa Clara River (Soledad Cyn)	403.55		E	E	E	E	E		E	E	
Pyramid Lake	403.42	E	E	E	E	E	P		E	E	
Canada de Los Alamos	403.43				I	I	I		I	I	
Gorman Creek	403.43				I	I			I	I	
Lockwood Creek	403.42				I	I			I	I	
Lockwood Creek	403.44				I	I	I		I	I	
Tapo Canyon	403.41				P				P	E	
Castaic Creek	403.51	I	I	I	I	I	I		I	E	
Castaic Lagoon	403.51		E	E	E	E	E		E	E	
Castaic Lake	403.51	E	E	E	E	E	E		E	E	
Elderberry Forebay	403.51	E	E	E	E	E	E		Ek	E	
Elizabeth Lake Canyon	403.51	I	I	I	I	I	I		I	E	
San Francisquito Canyon 1	403.51	I	I	I	I	I	I		I	E	
South Fork (Santa Clara River)	403.51		I	I	I	I	I		I	I	
Drinkwater Reservoir	403.51					E			Ek	E	
Bouquet Canyon	403.51	EI	EI	PI	PI	E	P		Em	E	
Bouquet Canyon	403.52	P	P	P	E	E	P		Em	E	
Dry Canyon Creek	403.51	I	I	I	I	I	I		I	I	
Dry Canyon Reservoir j	403.51	E	E	E	E	P	P		Pk	E	
Bouquet Reservoir	403.52	E	E	E	E	E	E		Pk	E	
Mint Canyon Creek	403.51	I	I	I	I	I	I		Im	I	
Mint Canyon Creek	403.53		I	I	I	I	I		Im	I	
Agua Dulce Canyon Creek	403.54		I	I	I	I	I		I	I	
Agua Dulce Canyon Creek	403.55				I	I	I		I	I	
Aliso Canyon Creek	403.55				P	E			E	E	
Lake Hughes	403.51	P	P	P	P	P	P		E	E	
Munz Lake	403.51		P	P	P	E	P		E	E	
Lake Elizabeth	403.51	P	P	P	P	P	P		E	E	

Continued.
Excerpt from 1994 *Basin Plan* Table 2.1: Beneficial Uses for Santa Clara River Watershed

Reach	WARM	COLD	EST	MAR	WILD	BIOL	RARE	MIGR	SPWN	SHELL	WET
Santa Clara River Estuary			E	E	E		Ee	Ef	Ef		E
Santa Clara River	E	E			E		E				E
Santa Clara River	E				E		E	E			E
Santa Clara River	E				E		E	E			E
Santa Clara River	E				E		E	E			E
Santa Clara River	E				E		E				E
Santa Clara River (Soledad Cyn)	E				E		Ei				E
Pyramid Lake	E	E			E		E				
Canada de Los Alamos	I	I			E		P				
Gorman Creek	I	I			E		P				
Lockwood Creek	I	I			E						
Lockwood Creek	I	I			E						
Tapo Canyon	E				E						
Castaic Creek	I				E		E				
Castaic Lagoon	E				E						
Castaic Lake	E	I			E		E		E		
Elderberry Forebay	E				E		E		E		
Elizabeth Lake Canyon	I				E						
San Francisquito Canyon 1	I				E		E		I		E
South Fork (Santa Clara River)	I				E						
Drinkwater Reservoir	P				E		E				E
Bouquet Canyon	E	E			E				P		E
Bouquet Canyon	E	E			E		E				E
Dry Canyon Creek	I				E						
Dry Canyon Reservoir j	E				E						
Bouquet Reservoir	E				E						
Mint Canyon Creek	I				E						
Mint Canyon Creek	I				E						
Agua Dulce Canyon Creek	I				E		E				
Agua Dulce Canyon Creek	I				E						
Aliso Canyon Creek	E				E						E
Lake Hughes	E				E						
Munz Lake	E				E						
Lake Elizabeth	E				E		E				

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